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A TAXONOMIC ACCOUNT OF THE LAST INSTAR LARVAE OF SOME BRITISH TIPULINAE (DIPTERA: TIPULIDAE).

By J. R. Chiswell.

(*Department of Zoology, University of Bristol.*)[1]

[With 110 Text-figures.]

Manuscript received 18th April, 1956.

(Read 3rd October, 1956.)

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I. Introduction.

Eighty-four species of Tipulinae have been recorded in Britain. The adults of all except two[2] of these species can be identified with the aid of the key given by Coe (1950), and there is an adequate taxonomic literature concerning them. The immature stages, however, have received relatively little attention since the classical work of Beling (1873, 1878, 1886), who described the larvae and pupae of thirty-nine European species of Tipulinae and gave keys to the larvae of four species of *Nephrotoma* and twenty-nine species of *Tipula*. Unfortunately, many of Beling's descriptions, which are not accompanied by illustrations, are of limited diagnostic value and some species were misidentified by him. Since the time of Beling, descriptions of the structure or biology of the larvae of some fourteen Palaearctic species have been published, but no attempt has been made to produce a key. The extensive bibliography of Hennig (1948–1950)

[1] Now at East Malling Research Station, near Maidstone, Kent.

[2] Two species have been added to the British list since Coe's key appeared; they are *Tipula livida* v.d. Wulp (Chiswell, 1954) and *Tipula seibkei* Zett. (Collin, 1954).

covers most of the literature and it is only necessary to mention here the more recent work of White (1951) on the life-history and biology of *Tipula lateralis* Meig. and that of Brauns (1954), which includes a general account of the larvae of Tipulinae with illustrations of several species.

In the present paper the last instar larvae of thirty-six species, including representatives of all seven of the British genera, are described and a key to species is provided.

The larvae of the great majority of species were identified by collecting the third or fourth instars and breeding them out, but larvae of *Tipula paludosa* Meig. and *T. oleracea* L. were reared from eggs. The larvae were kept in Petri dishes containing moist leaf mould, moss, or decaying wood as appropriate. Nearly all the species showed slight carnivorous tendencies, although an abundant supply of vegetable material was available, and it was therefore necessary to limit the number of larvae in each dish to five or six and to remove pupae as soon as they were found. Although a few species, such as *Tipula czizeki* De Jong and *T. luteipennis* Meig., overwinter in the egg stage (De Jong, 1925), the great majority overwinter as third or fourth instar larvae and do not pupate before late March at the earliest. It was found that overwintering larvae would pupate in January or February and sometimes in late December if they were collected in the previous October, November, or December and were allowed to feed at room temperatures. Larvae of twelve species were reared in this way during the winter months and all pupated early. The results show that the overwintering larvae do not diapause but are always capable of growth.

Larvae were preserved in Pampel's fluid. They were killed by immersion in hot water (50–60° C.) for a few seconds. This treatment expands the anal papillae and spreads the lobes of the spiracular disc and it is then easy to examine these structures, which are of great taxonomic importance.

All drawings were made with the aid of a camera lucida. All scale lines represent 1 mm., unless otherwise indicated. It is important to note that the marginal hair fringe of the spiracular disc is shown only in drawings of the disc itself and in posterior views of the last abdominal segment; it is omitted from dorsal, lateral, and ventral views of the last abdominal segment. In those species in which the marginal hair fringe is lacking, the boundary of the glabrous area of the spiracular disc is indicated by a dotted line (e.g. fig. 48).

II. Characters of Taxonomic Importance.

Alexander (1920) has listed the characters which he considered would prove to be of most value in distinguishing the larvae of the species of *Tipula*. These characters can, in fact, be used to distinguish the larvae of all the Tipulinae and it will be useful to give a general account of the more important of them here. They include the spiracular disc, the anal field, the cuticle and its pubescence, and the chaetotaxy.

(*a*) The spiracular disc.

With one known exception, the spiracular disc of the larvae of all the British Tipulinae is surrounded by six fleshy lobes arranged in dorsal, lateral, and ventral pairs. The exception is *Tipula subnodicornis* Zett. in which, according to Beling (1886), a fourth pair of lobes is present between the usual lateral and ventral pairs. In *Dolichopeza albipes* Stroem the dorsal lobes are very close together

with their median surfaces touching (fig. 37), but they are not fused as is often stated, and they can be easily separated with a needle.

The size and shape of the lobes varies considerably from species to species and is fairly closely correlated with the nature of the larval environment. As a general rule, the lobes of aquatic or semi-aquatic species (those which live in saturated or very wet soil and moss) are all moderately long with flattened posterior surfaces, whereas in more terrestrial species (those which live in moist but not saturated soil or in decaying wood) the dorsal and ventral lobes are considerably shorter than the lateral lobes and, although the ventral lobes are usually flattened, the dorsal and lateral lobes are conical. In some of the species that tunnel in decaying wood, such as *Dictenidia bimaculata* L. (fig. 42) and *Ctenophora pectinicornis* L. (fig. 47), the lobes of the disc are no shorter than those of many soil-living forms, but in others, such as *Ctenophora ornata* Meig. (fig. 46), *Tanyptera atrata* L. (fig. 44) and *Tipula flavolineata* Meig. (fig. 65), all the lobes are very short.

In all species, the cuticle on the upper surface of each ventral lobe and on the central area of the disc around the spiracles is glabrous and hydrofuge. In the great majority of the aquatic and semi-aquatic species, the glabrous area extends on to the posterior sides of the dorsal and lateral lobes and is fringed with usually fairly short hairs. The hairs are hydrofuge and are slightly flattened in the plane of the disc ; they are slightly longer and closer together[3] at the tips of the lobes. There is always a gap in the hair fringe between each lateral and ventral lobe, and in many species there are smaller gaps, either between the dorsal lobes or between the dorsal and lateral lobe on each side, or between both the dorsal lobes and the dorsal and lateral lobe on each side. In nearly all the more terrestrial species the glabrous area does not extend on to the dorsal and lateral lobes, and the marginal hair fringe is absent.

The posterior sides of the lobes nearly always bear pigmented stripes or patches which are usually sufficiently constant in size and shape within a species and sufficiently different between species to be of great diagnostic value. In the aquatic and semi-aquatic species there is usually a brown or pale brown stripe on one or both margins of each lobe, with darker patches at the base and tip of each ventral lobe. The more terrestrial species show a greater variation in the size, shape, and position of the pigmented areas, which are often heavily sclerotised and dark brown or black. In general, however, the dorsal and lateral lobes have a median longitudinal stripe or a patch at the base. The pigmentation of the ventral lobes may be confined to small patches at the base and tip (fig. 60), or may extend over the entire upper surface of the lobe (fig. 66).

A number of sensory setae are always present on the spiracular disc. Most of them are short and inconspicuous and have been overlooked by previous writers. The setae nearly always arise on, but near the edge of, the glabrous area of the disc. In species in which the dorsal and lateral lobes are largely glabrous and fringed with hairs (e.g. fig. 91) there is one seta near the tip of each dorsal lobe and four setae on each lateral lobe—two on the dorsal margin usually near the base of the lobe and two very close together near the tip. Each ventral lobe has five setae, all near the tip ; one is very long and arises from an

[3] The greater proximity of the hairs around the tips of the lobes results in their being no further apart than those at the sides of the lobes when the latter are spread out at an air-water interface.

unpigmented spot in the brown patch at the tip of the lobe ; the other four are short and arise between the brown patch and the hair fringe, and the middle two of the four are very close together. Among the species in which the glabrous area does not extend on to the dorsal and lateral lobes the number and position of the setae is more varied. There are always one or two setae on each dorsal lobe, usually near its base and close to or on the pigmented patch that is present in nearly all species. Three or four setae arise on or near each lateral lobe ; two of these setae always arise close together, either at the base of the lobe (e.g. figs. 47 and 65) or, in species with a longitudinal stripe on the lobe, either at the end of the stripe (e.g. figs. 60 and 61) or near its middle (e.g. figs. 66 and 67) ; the remaining one or two setae always arise at the base of the lobe, usually above the spiracle and a short distance from the first two setae when these are at the base of the lobe. The setae at the tip of each ventral lobe vary in number from four in *Tipula rubripes* Schum. (fig. 60) to seven in *T. flavolineata* Meig. (fig. 65), but in most species there are five. In some species, one of these setae is much longer than the others (e.g. figs. 48, 56, 78, 99) and in *Tanyptera atrata* L. (fig. 44) there are two such long setae. In many other species (e.g. figs. 42, 50, 69, 82, 86), all the setae are short.

(*b*) The anal field.

The anus and the anal papillae are always separated from the other parts of the last abdominal segment by a narrow circular band of thickened and pigmented cuticle, and I have used the term " anal field " to describe the area inside this band. The anal field is glabrous in the great majority of species. The anal papillae occupy the anterior part of the field, and the anus opens on the posterior part. The papillae are partly retractile, and the whole anal field can be folded inwards to some extent. In nearly all species the walls of the anus are raised into eight radial cushion- or pad-like folds (e.g. fig. 92), but in *Tipula pruinosa* Weid. (fig. 106) the anal opening is a simple transverse slit. Two species, namely *Tipula rubripes* Schum. (fig. 60) and *T. scripta* Meig. (fig. 61), are unusual in that the anus is separated from the anal papillae by a narrow pigmented band similar to the band that surrounds the entire anal field.

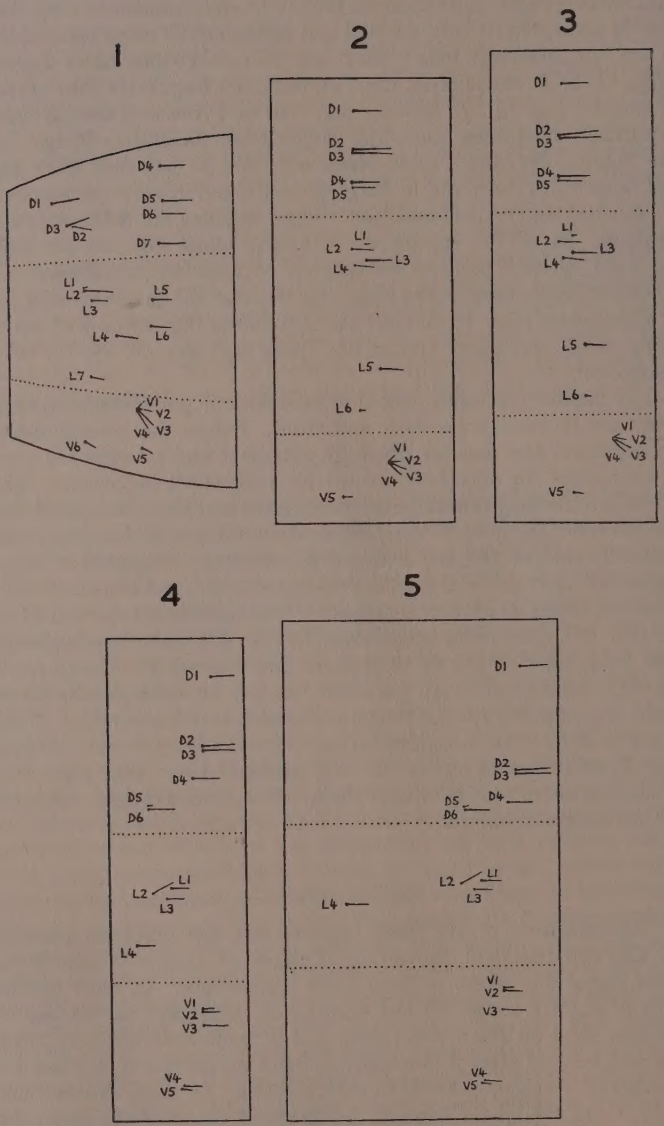
Four anal papillae are present in the majority of species, including all those that are more or less terrestrial and many that are semi-aquatic, but some of the aquatic and semi-aquatic forms have six papillae and others eight. The characteristic, and probably primitive, number of papillae in the whole of the Tipulidae is four, but Alexander (1920 : 748) apparently considered that in the Tipulidae the primitive number is eight and that one or two pairs have been lost in those species with four or six papillae. Alexander's view is not supported by the available ontogenetic evidence. For instance, White (1951) has found that in *Tipula lateralis* Meig. the first instar larva has only two pairs of anal papillae, whereas the second, third, and fourth instars have three pairs (fig. 105) ; the posterior ventral pair is formed at the first moult. I have confirmed White's findings and have found that a similar development occurs in *Tipula maxima* Poda. In this species the third and fourth instars, and probably the second, have eight anal papillae (fig. 75), but in the first instar only the four long lateral papillae are clearly developed ; in some specimens there is a pair of slight swellings which, from their position, may represent the more anterior of the two short ventral pairs of papillae that are present in the later stages.

The shape and, particularly, the length of the anal papillae is correlated to a considerable extent with the nature of the larval environment. In most species which live in saturated or very wet soil and debris one or more pairs of the anal papillae are comparatively long ; they may be rather stout, as in *Tipula luna* Westh. (fig. 81) or *T. vittata* Meig. (fig. 79), but more frequently they are slender, as in *T. maxima* (fig. 75), *T. lateralis* (fig. 105) or *Prionocera turcica* Fabr. (fig. 41). A number of species, including *Nephrotoma flavipalpis* Meig. (fig. 49), *N. analis* Schum. (fig. 48), *Tipula oleracea* L. and *T. paludosa* Meig. (fig. 92), are found both in very wet and in fairly dry soils, and in such species the lateral papillae are short and conical and the ventral papillae are reduced to rounded protuberances. In all the species which live in moist but not wet soil or in decaying wood, all four papillae are reduced to rounded protuberances. Such species include *Tipula flavolineata* Meig. (fig. 65) and all the species of *Tanyptera* (fig. 44), *Ctenophora* (figs. 46 and 47) and *Dictenidia* (fig. 42), all of which live in decaying wood, and many species of *Tipula* (e.g. figs. 60, 66, 72, 86) which live in moist soil.

The anal papillae certainly assist in locomotion, particularly in species in which they are short or both short and stout. Before the circular muscles of the body contract, the papillae are fully extended and provide the necessary point of anchorage for effective forward (or backward) movement. They are retracted before the longitudinal muscles contract and the hind end of the body is drawn forwards. In most of the species which burrow in decaying wood, the postero-ventral part of the last segment is somewhat elongated in a postero-ventral direction, and the anal field is thus borne at the end of a short and thick peduncle which forms an effective ' pusher '. This condition is seen in *Tanyptera atrata* L. (fig. 45), *Dictenidia bimaculata* L. (fig. 43) and *Tipula flavolineata* Meig., and to a lesser extent in *Ctenophora pectinicornis* L. The physiological functions of the anal papillae are unknown, but it is probable that in at least the aquatic and semi-aquatic species they are concerned with absorption of chloride ions, as is well known for mosquito larvae. Brown (1910) found that the anal papillae of *Tipula maxima* larvae are well tracheated and that there is a considerable circulation of blood through them. He considered that they probably assist in respiratory exchanges.

(*c*) The cuticle

With the exception of the head capsule and the glabrous areas of the spiracular disc and anal field, the cuticle of almost all species is entirely clothed with rather dense and short or very short pubescence. In most species the pubescence is slightly longer on the dorsal side, especially of the last one or two segments, than on the ventral side, and it is shortest on the pleura. On the dorsal and ventral sides it is usually divided by narrow transverse furrows into a number of contiguous bands in each segment. In many species there are small tufts of slightly longer hairs at the bases of many of the sensory setae, and in a few species such as *Tipula pruinosa* Wied. (figs. 106 and 109) and *T. variicornis* Schum. (figs. 58 and 59) there are bands or tufts of much longer hairs on the dorsal side of the last segment. The pubescence is greyish or brownish : it is usually uniform in colour but in some species, such as *Dolichopeza albipes* Stroem (fig. 38), *Tipula solstitialis* Westh. (fig. 102) and *Tipula cheethami*



FIGS. 1–5.—*Dolichopeza albipes* Stroem. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (1) Prothorax. (2) Mesothorax. (3) Metathorax. (4) First abdominal segment. (5) Abdominal segments 2–7, inclusive.

Edw. (fig. 95), it forms a system of longitudinal stripes and patches on the dorsum. In most species the pubescence is sufficiently dense largely to determine the general colour of the larva. The cuticle itself, however, is always unpigmented and translucent, so that in those species in which the pubescence is comparatively sparse (*Tipula flavolineata* Meig. and *T. livida* v. d. Wulp) or absent from most segments (*Dictenidia bimaculata* L. and *Tanyptera atrata* L.) the general colour of the larva is that of the white or creamy-white fat-body.

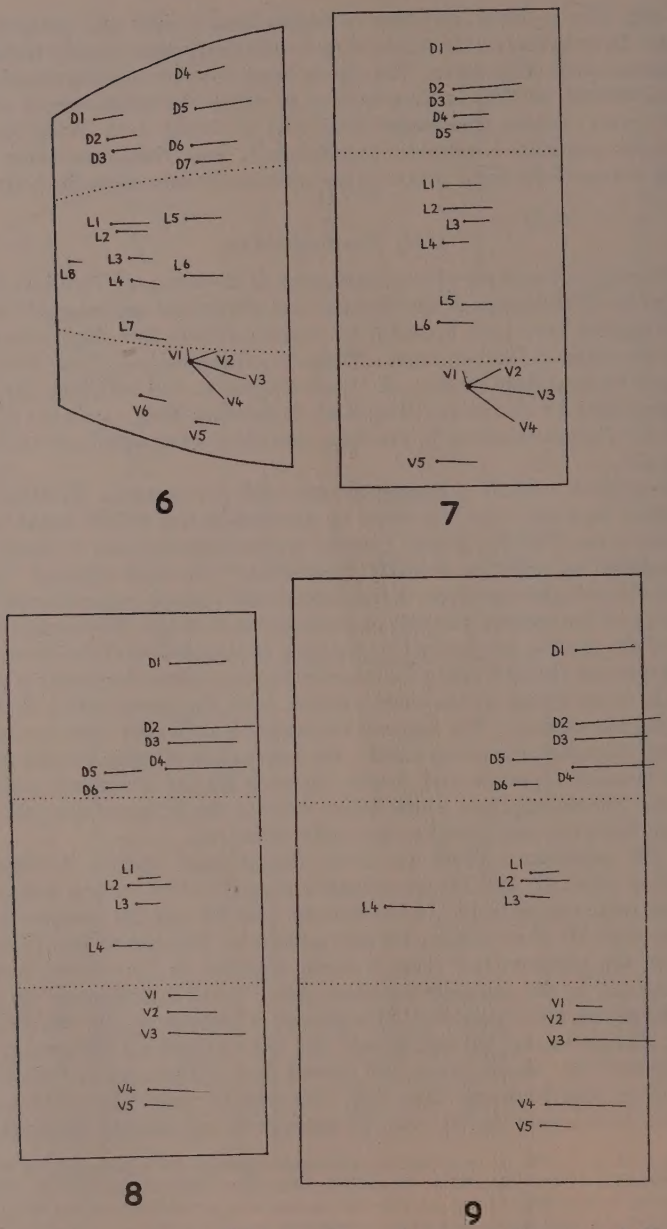
(*d*) The chaetotaxy.

No comparative study of the chaetotaxy of the larvae of Tipulinae has been made so far. Setal maps of the thoracic and abdominal segments of the larvae of four species have been provided by various writers, but they have not described the setae in further detail. Moreover, Bodenheimer (1924) has omitted many of the setae from his map of *Tipula oleracea* L. and, although the maps of Oldham (1928) for *T. lateralis* Meig. and *T. paludosa* Meig., and that of Hennig (1950) for *Tanyptera atrata* L. are more accurate, a few setae are nevertheless overlooked.

The present account is concerned only with the setae on the thoracic and abdominal segments, and it is based on an examination of last instar larvae of representatives of all the British genera. A provisional system of nomenclature is introduced in order to simplify description.[4] On each segment the setae are considered in three groups—dorsal, lateral, and ventral—according to whether they arise on the tergum, pleuron, or sternum respectively. The upper and lower limits of the pleuron are marked by the lines of attachment of the dorso-ventral pleural muscles. In each group the setae are numbered in order (as far as possible) from the most dorsal to the most ventral, with the group letter D, L, or V preceding the number. The segment concerned is indicated when necessary by a symbol preceding the group letter ; the convention of using Roman numerals for the thoracic segments and Arabic numerals for the abdominal segments is adopted. The descriptions which follow refer to the setae on one half of each segment, from the mid-dorsal to the mid-ventral line.

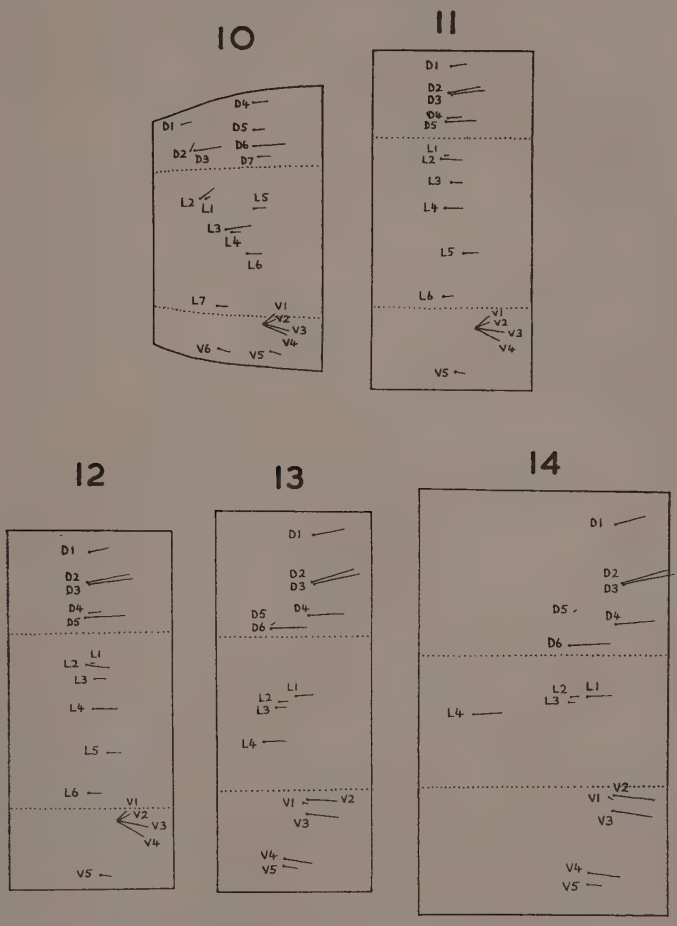
(i) *The prothorax.*—There are seven dorsal setae (except in *Nephrotoma* (fig. 23) in which D2 and D3 are absent) arranged in two vertical rows of three and four setae respectively. In the anterior row D2 and D3 always arise close together with D2 shorter than D3 and, except in *Dolichopeza* (fig. 1), anterior to it. In the posterior row there is much variation in the relative lengths of the setae and in the distances between them. Seven lateral setae are present in all the genera and an eighth (L8) is present in *Ctenophora* (fig. 19), *Prionocera* (fig. 6), *Tanyptera* (fig. 15) and *Tipula* (fig. 28). L1 and L2 always arise close together with L1 shorter than and dorsad from L2 (except in *Prionocera*, in which L1 is slightly longer than L2). L3 and L4 arise fairly close together, except in *Dolichopeza* (fig. 1), with L3 anterior to and usually longer than L4.

[4] The system should be regarded as provisional because the chaetotaxy of the other two subfamilies of the Tipulidae, viz. : Cylindrotominae and Limoniinae, has not been studied and it is therefore not possible to consider the chaetotaxy of the Tipulinae in relation to that of the family as a whole. Moreover, no first instar material of most of the genera has been available and I have, therefore, been unable to distinguish between the setae which are present in the first instar and any which may be developed in the later stages.



FIGS. 6–9.—*Prionocera turcica* Fabricius. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (6) Prothorax. (7) Meso- and metathorax. (8) First abdominal segment. (9) Abdominal segments 2–7 inclusive.

L8 is a very short seta which arises close to the anterior edge of the segment. There are six ventral setae. V1–V4 arise very close together [5] near the lateral edge of the sternum and V5 and V6 arise more ventrally with V6 anterior to V5. Some of the more anterior prothoracic setae, including D1, L8, V6, and probably D2 and D3, are not represented on the other segments. They have probably been evolved in relation to the special sensory requirements of the prothorax, which is the most anterior part of the larva when the head is retracted into it.



FIGS. 10–14.—*Dictenidia bimaculata* L. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (10) Prothorax. (11) Mesothorax. (12) Metathorax. (13) First abdominal segment. (14) Abdominal segments 2–7 inclusive.

[5] Hennig (1950, fig. 220) shows only two of these setae in his map of *Tanyptera*.

(ii) *The meso- and metathorax.*—The chaetotaxy of these two segments is so similar that they can be considered together. There are five dorsal setae. D2 and D3 are always fairly long and stout and arise very close together in all the genera except *Prionocera* (fig. 7). D4 and D5 usually arise fairly close together and D4 is shorter than D5 except in *Dolichopeza* (figs. 2 and 3) and *Prionocera*. There are six lateral setae. L1 is very short, except in *Prionocera*, and usually arises close to L2 above and slightly behind it. L6 is short except in *Prionocera* and *Tanyptera* (fig. 16) and on the mesothorax of some species of *Nephrotoma* (fig. 24). The other four lateral setae show considerable variation in their relative lengths and in the distances between them, but L2 and L4 are often longer than L3 and L5 and, with L6, form a more or less vertical row that is slightly anterior to L3 and L5. There are five ventral setae. V1–V4 arise very close together near the lateral edge of the venter and V5 arises anterio-ventrad from them. V1–V4 are clearly the homotypes of V1–V4 on the prothorax, and V5 is probably the homotype of the prothoracic V5.

(iii) *The abdomen.*—The first abdominal segment is narrower than the others and the setae on it arise at or slightly behind its middle, as do the setae on the meso- and metathorax. Each of abdominal segments two to seven is divided by a fairly conspicuous furrow into a broader anterior part and a narrower posterior part, and all the setae except L4 arise on the posterior part. Apart from the position of one or two of the setae on the first segment, the number, length, and arrangement of the setae is the same on each of the first seven segments, and they can therefore be considered together. The six dorsal setae are arranged in two vertical rows, an anterior row of two (D5 and D6) and a posterior row of four (D1–D4). D5 is very short, except in *Prionocera* (figs. 8 and 9), and always arises dorsad from D6 but a variable distance from it. D5 is very close to D6 in *Dolichopeza* (figs. 4 and 5), *Nephrotoma* (figs. 26 and 27), and some species of *Tipula* (figs. 35 and 36), but in other species of *Tipula* (figs. 30 and 31) and in *Prionocera* and *Tanyptera* (figs. 17 and 18) it is far from D6 and arises at or above the level of D4. In *Ctenophora* (figs. 21 and 22) and *Dictenidia* (figs. 13 and 14) D5 is close to D6 on the first segment but is far from it on segments two to seven. In the posterior row, D2 and D3 arise very close together (or, in *Prionocera*, fairly close together) and they are usually nearer to D4 than to D1. There are four lateral setae. L1, L2, and L3 arise fairly close together below D6 and are arranged either in the form of an inverted triangle, as in *Nephrotoma*, *Dolichopeza*, *Prionocera* and *Tipula*, or in an oblique line, as in *Ctenophora*, *Dictenidia* and *Tanyptera*. On each of segments two to seven, L4 arises at or slightly below the level of L1–L3 and a considerable distance in front of them. On the narrower first segment, L4 is still the most anterior seta but it is much closer to the other three setae and arises in a more ventral position well below the level of L3 (except in *Tanyptera* (fig. 17) in which it arises directly anterior to L3). The relative lengths of the lateral setae vary a good deal, but L1 and L4 are usually stouter than L2 and L3. Five ventral

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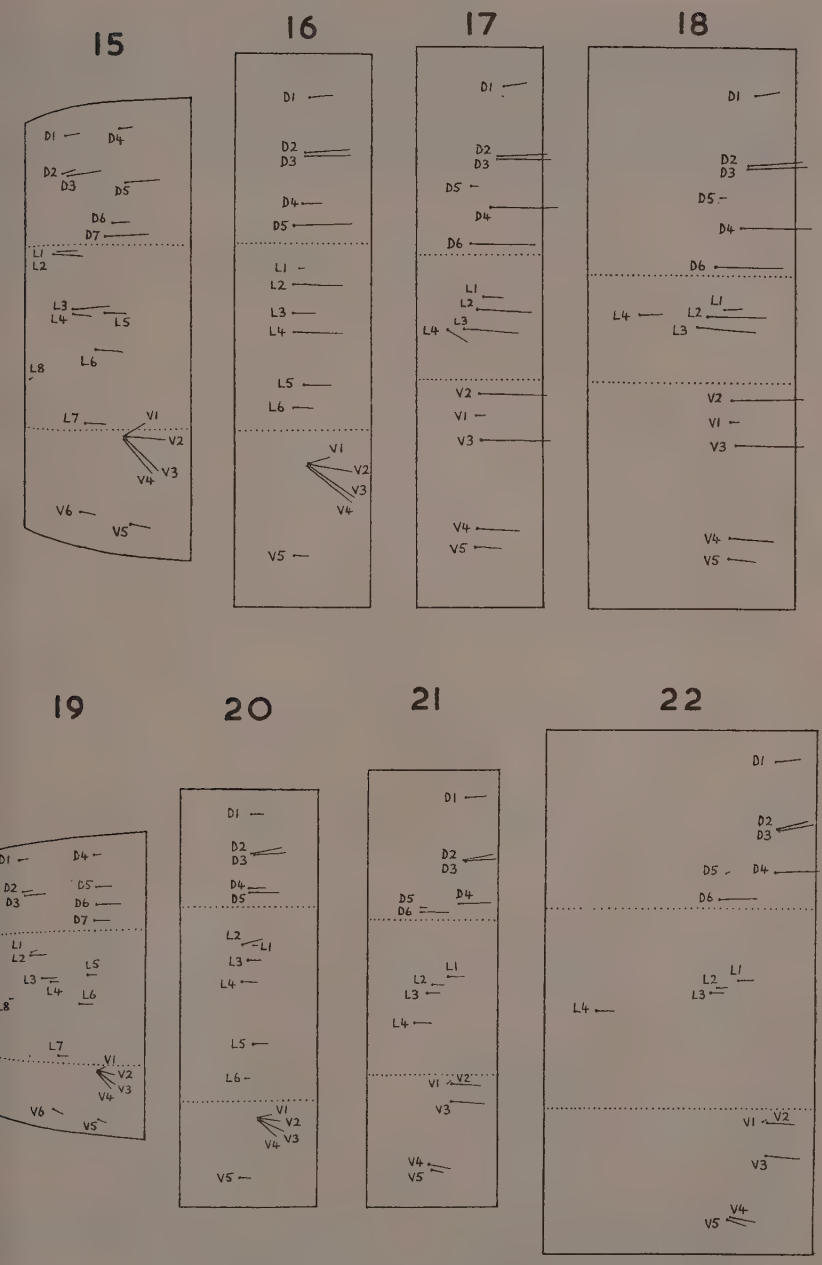
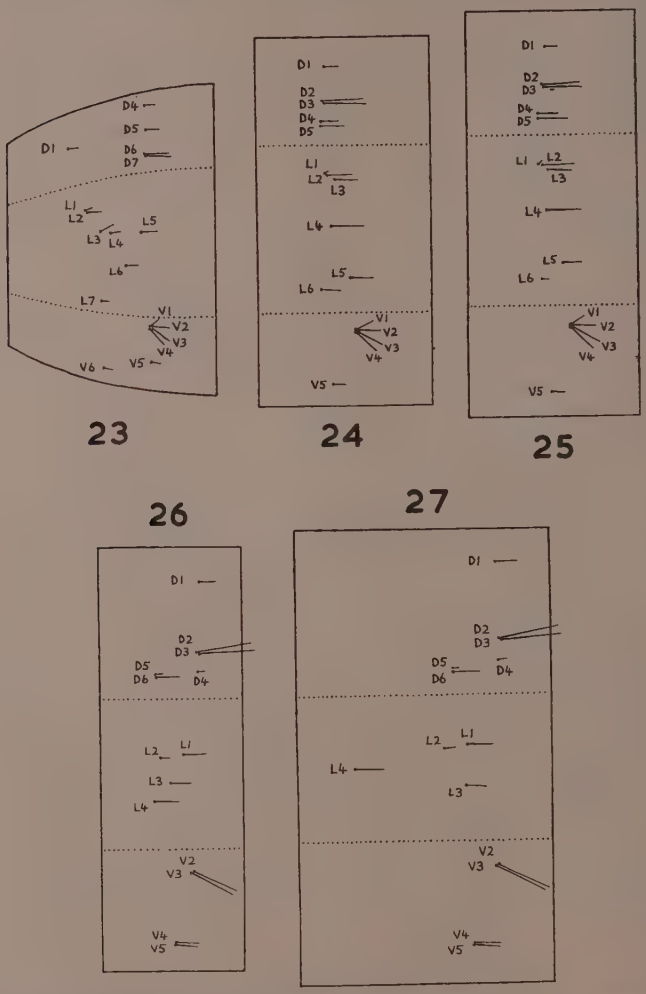
Figs. 15–22.—Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (15) *Tanyptera atrata* L., prothorax. (16) Same, meso- and metathorax. (17) Same, first abdominal segment. (18) Same, abdominal segments 2–7 inclusive. (19) *Ctenophora pectinicornis* L., prothorax. (20) Same, meso- and metathorax. (21) Same, first abdominal segment. (22) Same, abdominal segments 2–7 inclusive.



FIGS. 15–22.—*For explanation see opposite page.*

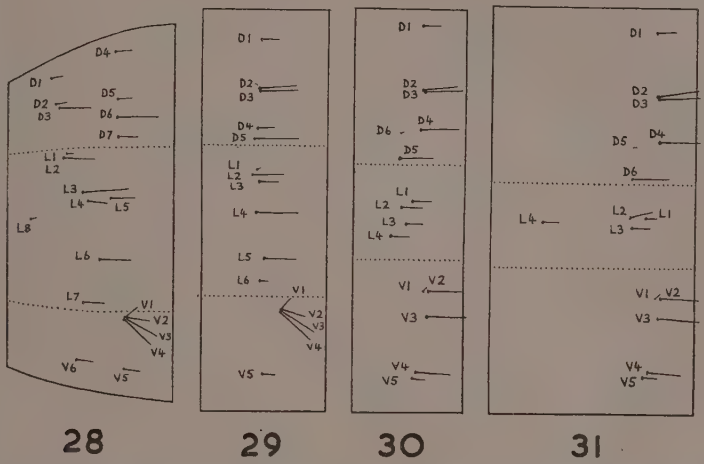
setae are present in all the genera except *Nephrotoma* in which V1 is absent. V1, V2 and V3 are latero-ventral in position, V4 and V5 are more ventral and are slightly anterior to the first three setae. V1 is a very short seta which arises close to V2, except in *Tanyptera* (figs. 17 and 18) in which it is mid-way between V2 and V3. V2 and V3 are usually fairly long and arise fairly close together; they are very close together in *Nephrotoma* (figs. 26 and 27). V4 and V5 arise close or fairly close together; they are usually shorter than V2 and V3, and V5



FIGS. 23–27.—*Nephrotoma quadrifaria* Meigen. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (23) Prothorax. (24) Mesothorax. (25) Metathorax. (26) First abdominal segment. (27) Abdominal segments 2–7 inclusive.

is shorter than V4 except in *Nephrotoma*. The setae on the first seven abdominal segments differ in number and arrangement from those on the thoracic segments but it seems likely that at least some of the abdominal setae are homotypes of thoracic setae. Thus D1, D2, and D3 on the abdomen are probably the homotypes of D1, D2, and D3 respectively on the meso- and metathorax and of D4, D5, and D6 respectively on the prothorax. No further homotypy is apparent, although V4 and V5 on the abdomen correspond in position to V5 on the thorax and V1, V2, and V3 on the abdomen similarly correspond to the group V1–V4 on the thorax.

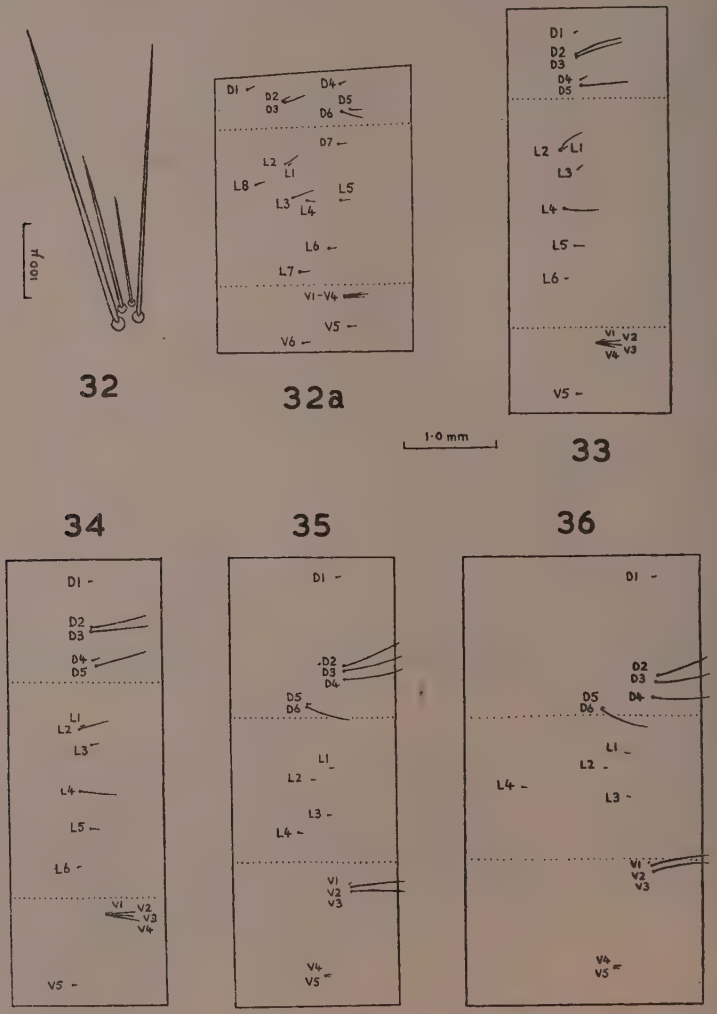
The setae on the glabrous area of the spiracular disc have been described in a previous section but other setae are present on the last segment, and they are



FIGS. 28–31.—*Tipula flavolineata* Meigen. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (28) Prothorax. (29) Meso- and metathorax. (30) First abdominal segment. (31) Abdominal segments 2–7 inclusive.

considered here. It has not been possible to determine the homology of all these setae, and I have therefore not named them. There are usually two setae on each lateral lobe of the spiracular disc. The first is fairly long and stout and arises at or near the middle of the ventral side of the lobe. The second is very short and arises on the dorsal side of the lobe, usually near its middle but sometimes near its tip, as in *Ctenophora pectinicornis* L. (fig. 47). Two or three setae arise in a more or less vertical row immediately anterior to each lateral lobe ; when three setae are present, as in *Tipula irrorata* Macq. (fig. 84), the most dorsal is very short and the others are fairly long. The most dorsal seta appears to be the one that is lost in forms such as *Dictenidia* (fig. 43), which have only two setae in this position. Seven to nine setae arise on or near each ventral lobe. Three or four of these arise on the ventral side of the lobe itself, and four or five arise latero-ventrally slightly anterior to the base of the lobe. The relative lengths of the nine setae vary considerably between species, and their arrangement

varies both between species and between individuals of the same species. Finally, on each side of the segment, there are four setae which arise anterior to the anal field. One of them is very short and arises close to the marginal band of the anal field (e.g. fig. 92); it is often very difficult to see but is present in the great majority of species. The other three setae are present in all species



FIGS. 32–36.—*Tipula livida* v. d. Wulp. Maps of setae on thoracic and first seven abdominal segments, showing left side of each segment. (32) High-power drawing of the setal group V1–V4 on prothorax. (32*a*) Prothorax. (33) Mesothorax. (34) Metathorax. (35) First abdominal segment. (36) Abdominal segments 2–7 inclusive.

nd are usually fairly long and stout. They lie in a vertical or slightly oblique ow some distance in front of the anal field, and the most dorsal seta (which is teral in position) is widely separated from the other two. Some of the setae n the last segment may be the homotypes of setae on the other abdominal gments, although such a relationship is nowhere apparent ; others are almost rtainly not represented on any other segment.

III. Generic Characters.

Owing to the apparent absence of satisfactory generically diagnostic features the larvae, it has not been possible to make a key to the British genera. eatures peculiar to the genus are found only in three of the seven genera, mely *Dolichopeza*, *Nephrotoma* and *Prionocera*. The larva of *Dolichopeza bipes* Stroem (the only British species of the genus) differs from all other known rvae in that the dorsal lobes of the spiracular disc arise very close together g. 37). It is not at present possible to decide whether or not this feature is aracteristic of the genus because the larvae of the other species of *Dolichopeza* e unknown. *Nephrotoma* larvae have a pair of welts or pads on the dorsal le of the prothorax (fig. 55). Such welts are absent from larvae of the other itish genera. Larvae of *Prionocera* are characterised by the fact that the bes of the spiracular disc are very long and slender and are fringed with long irs (fig. 40). The hairs of the marginal fringe are also very long on the spiracu- disc of *Tipula cheethami* Edw. (fig. 94), but the lobes of the disc of this ecies, although they are longer than in most species of *Tipula*, are shorter d much stouter than in *Prionocera*. Larvae of the other four British genera— *enophora*, *Dictenidia*, *Tanyptera* and *Tipula*—lack characters that are agnostic for the genus. The characters used to separate these genera in the ys of Alexander (1920) and Hennig (1950) are not satisfactory. Alexander scribed the larva of the Nearctic *Ctenophora apicata* O.S. as possessing a nder flexible seta on the dorsal side of the head behind the antenna, and he ed the presence of this seta to distinguish larvae of *Ctenophora* from those of *ionocera*, *Holorusia*, *Tipula* and *Nephrotoma*. However, in all larval Tipulinae ere are several setae on the clypeus behind the antennae, and these setae are more developed in *Ctenophora ornata* Meig. or *C. pectinicornis* L. than they e in species of the other six genera which I have examined. Alexander's key aracters for *Tanyptera*, namely, " Spiracular disk with lobes indistinct ; ing in nearly solid or semi-decayed wood ", do not exclude *Ctenophora ornata* ig. (cf. figs. 44 and 46). Hennig has attempted to distinguish the larvae of *enophora*, *Dictenidia* and *Tanyptera* from those of other genera of Tipulinae the grounds that, when the spiracular disc is closed, the ventral lobes are posed to the central part of the disc much more firmly in these than in the ier genera. No such difference exists. In *Dolichopeza*, *Nephrotoma*, and many cies of *Tipula*, the spiracular disc is closed just as firmly and in the same way it is in *Ctenophora*, *Dictenidia* and *Tanyptera*. In this connection it should be nted out that the species illustrated in Hennig's figures 209, 210, and 212, first two of which are intended to show the firm closure of the spiracular c, is not in fact *Ctenophora pectinicornis* but a species of *Tipula*, probably *selene* Meig. Moreover, his figure 214 shows the spiracular disc of *Tipula olineata* Meig., not that of *Tanyptera atrata* L.

IV. Subgenera of *Tipula*.

About one thousand species of *Tipula* have been described and, on the basis of adult characters alone, more than twenty subgenera have been erected[6]. The majority of these subgenera are not very clearly distinguished from each other and lack well-defined diagnostic characters. According to Audcent (1932), the British species fall into six subgenera, viz.: *Acutipula* Alex., 1924 ; *Anomaloptera* Lioy, 1864 ; *Lunatipula* Edw., 1931 ; *Schummelia* Edw., 1931 ; *Vestiplex* Bezzi, 1924 ; and *Tipula* L., *s.str.* The evidence available from the present study of the larval stages supports the view that at least two of these subgenera, namely *Acutipula* and *Lunatipula*, are well founded and represent natural species-groups. *Acutipula* includes *T. maxima* Poda, *T. fulvipennis* Deg. and *T. vittata* Meig. The spiracular discs of the larvae of these species are very similar (cf. figs. 73, 74, and 78), but the larvae of the first two species have eight anal papillae whereas those of *T. vittata* have four. *T. luna* Westh. should, perhaps, be included in *Acutipula* because the adults possess most of the diagnostic features of this subgenus and the larvae are fairly similar to those of *T. vittata*. The subgenus *Lunatipula* includes *T. brevispina* Pierre, *T. selene* Meig., *T. lunata* L., *T. cava* Ried. and *T. livida* v. d. Wulp. The anal fields and spiracular discs of the larvae of the first four species are very similar (cf. figs. 66, 67, 68, and 69), and, moreover, the discs are quite unlike those of species of other subgenera. Larvae of *T. livida* differ from those of all the other species described here in that the dorsal and lateral lobes of the spiracular disc are entirely sclerotised and hook-like (fig. 62). The nearest approach to the structure of *T. livida* is, however, to be seen in other species of *Lunatipula*, such as *T. brevispina* and *T. selene*, in which the apical half of each dorsal lobe of the spiracular disc is entirely sclerotised and hook-like. The subgenus *Anomaloptera* contains only one species, *T. nigra* L., the larvae of which I have not seen. The subgenus *Schummelia* is represented in Britain by two species, *T. variicornis* Schum. and *T. yerburyi* Edw., the adults of which are very similar. The larvae of *T. yerburyi* are unknown but those of *T. variicornis* (figs. 56–59) are certainly very different from those of any other species that I have examined. The subgenus *Vestiplex* includes *T. nubeculosa* Meig., *T. rubripes* Schum. and *T. scripta* Meig. The larvae of the last two species are very similar (cf. figs. 60 and 61), and they differ from those of all the other species known to me in having a sclerotised band between the anal papillae and the anus. Brauns' (1954) figure of *T. nubeculosa* shows that the spiracular disc and anal field of this species resemble those of *T. rubripes* and *T. scripta*, although it does not unmistakably show a sclerotised band between the anus and the anal papillae. The remaining subgenus, *Tipula s.str.*, includes thirty-seven British species. As Audcent has pointed out, some of these species can be arranged in groups but the remainder do not appear to be closely related to each other. I have examined larvae of two species from each of the four groups which Audcent listed, and I have found that in each group the larvae are similar whereas larvae from different groups are dissimilar. The first group includes *T. oleracea* L., *T. paludosa* Meig. and *T. czizeki* De Jong. The larvae of these three species are identical according to De Jong (1925) and Sellke (1936). I have examined larvae of *T. oleracea* and *T.*

[6] The characters of the subgenera have been discussed by Edwards (1931).

paludosa, and have been unable to distinguish them. The second group includes *T. couckei* Tonn., *T. coerulescens* Lack., *T. montium* Egger, *T. lateralis* Meig. and *T. solstitialis* Westh. The larvae of the first three species are unknown, but those of *T. lateralis* and *T. solstitialis* are certainly very similar. The third group includes *T. mutila* Wahl., *T. pseudovariipennis* Czizek, *T. variipennis* Meig. and *T. hortulana* Meig. The larvae of at least the last two of these species are very similar. The fourth and last group includes *T. alpium* Bergr., *T. obsoleta* Meig., *T. staegeri* Niels., *T. signata* Staeg., *T. vafra* Ried., *T. cheethami* Edw., *T. marmorata* Meig. and *T. rufina* Meig. The larvae of the last three species differ from those of species from the other groups of *Tipula s.str.* and from the other subgenera in having eight short or very short anal papillae that are arranged in two transverse rows of four (figs. 97 and 98). It seems likely that the larvae of the other species in this group will be found to have the same number and arrangement of the anal papillae.

V. Key to Last Instar Larvae of Tipulinae.

1 Spiracular disc with eight lobes; dorsum with three dark longitudinal stripes and, on each segment, a transverse row of four to six small tooth-like processes, each process with heavily sclerotised posteriorly directed tip; anal field with four long and pointed anal papillae, lateral pair longer than ventral pair
Tipula subnodicornis Zett. (p. 482)

– Spiracular disc with six lobes (sometimes extremely short and no more than rounded protuberances) or with apparently five lobes . . . 2

2 Spiracular disc with apparently five lobes, i.e. dorsal lobes very close together (fig. 37); larva green, dorsum with two dark brown longitudinal zig-zag stripes; anal papillae reduced to four rounded lobes anterior to anus . . . . . **Dolichopeza albipes** Stroem (p. 432)

– Spiracular disc with six lobes, dorsal lobes clearly separated . . . 3

3 Spiracular disc with all lobes long and very slender, between three and four times as long as breadth at base; marginal hair fringe present, hairs very long; each lobe with dark brown or black marginal and median longitudinal stripes (fig. 40); anal field with six long and slender anal papillae (fig. 41)
genus **Prionocera** Loew (**P. turcica** Fabr. p. 433)

– Spiracular disc either with lobes not more than twice as long as breadth at base, or marginal hair fringe absent 4

4 Dorsal and lateral lobes of spiracular disc entirely sclerotised as long slender anteriorly curved horns; ventral lobes very short, broad and fleshy; marginal hair fringe absent (fig. 62); anal papillae represented by four rounded lobes anterior to anus (fig. 63); larva whitish . . . . . **Tipula livida** v. d. Wulp (p. 449)

– Dorsal and lateral lobes of spiracular disc not as above, sclerotisation usually confined to posterior surfaces of all lobes, some species (**Tipula lunata** group) with at most apical half of each dorsal lobe entirely sclerotised and hook-like 5

5 Dorsal and lateral lobes of disc small and very short, not longer than breadth at base (figs. 44, 46, and 65); ventral lobes very short and broad; anal papillae reduced to four rounded lobes, two on each side of anus; larvae whitish, in decaying wood. 6

– Dorsal and lateral lobes of disc longer than in figs. 44, 46, and 65 : *either* with lateral and usually dorsal lobes clearly longer than breadth at base *or* larvae greyish or brownish and not in decaying wood 8

6 Spiracular disc with marginal hair fringe, hairs fairly short ; each ventral lobe of disc with two dark brown spots at base, and a short dark brown median longitudinal stripe at tip ; dorsal and lateral lobes reduced to rounded protuberances, each with a large brown or pale brown patch at base (fig. 46) . **Ctenophora ornata** Meig. (p. 438)

– Spiracular disc without marginal hair fringe ; each ventral lobe with pigmentation confined to a brown patch at tip ; dorsal and lateral lobes with pigmented patches much smaller than in *C. ornata* (figs. 44 and 65) 7

7 Dorsal and lateral lobes of disc extremely short and rounded ; dorsal lobes unpigmented ; each lateral lobe with a long slender seta at tip ; each ventral lobe with a small brown or dark brown patch at tip (fig. 44) . . . . . **Tanyptera atrata** L. (p. 437)

– Dorsal and lateral lobes of disc short and pointed ; each dorsal lobe usually with a small pale brown patch at base ; each lateral lobe with a long, slender seta on outer (lateral) side, far removed from tip ; each ventral lobe with a brown transverse, usually broadly V-shaped, stripe at tip (fig. 65) . . **Tipula flavolineata** Meig. (p. 480)

8 Dorsal side of prothorax with a pair of distinct raised welts (fig. 55) ; spiracular disc with lateral lobes unpigmented ; each dorsal lobe sometimes with a small dark patch at base ; each ventral lobe with a transverse row of three dark spots at base, and a dark patch at tip ; dorsal and lateral lobes conical, lateral lobes nearly twice as long and thick as dorsal lobes ; glabrous area of disc not extending on to dorsal or lateral lobes ; marginal hair fringe absent ; anal field with two pairs of anal papillae, ventral pair reduced to rounded protuberances, lateral pair pointed or rounded and never more than twice as long as breadth at base . . . (genus **Nephrotoma** Meig.) 9

– Dorsal side of prothorax without welts ; each lateral lobe of spiracular disc always with one or more pigmented stripes or patches, either on lobe itself or at its base 12

9 Each dorsal lobe of spiracular disc unpigmented ; each ventral lobe with a basal transverse row of three dark brown spots in a pale brown transverse stripe, outermost spot elongate ; tip of lobe moderately narrow with a small dark brown patch and five setae, four very short and one very long ; spiracles with ventral margins flattened or slightly concave ; lateral anal papillae rounded, scarcely longer than breadth at base (fig. 49) . **Nephrotoma flavipalpis** Meig. (p. 440)

– Each dorsal lobe of spiracular disc with a small dark brown spot or patch at base[7] 10

10 Lateral anal papillae with pointed tips, nearly twice as long as breadth at base ; each ventral lobe of spiracular disc very narrow towards tip ; tip with five setae, one very long and four very short ; base with a transverse row of three dark brown spots in a pale grey transverse stripe, outermost spot elongate (fig. 48) **Nephrotoma analis** Schum. (p. 442)

[7] This patch is absent from some specimens of *N. flavescens* L., but in this species the ventral lobes of the disc are shorter and broader than they are in *N. flavipalpis* and all five of the setae at the tip of each ventral lobe are short, whereas in *N. flavipalpis* one of the five setae is very long.

– Lateral anal papillae rounded, scarcely as long as breadth at base; each ventral lobe of spiracular disc broad towards tip; tip with five very short setae; base with a transverse row of three dark brown spots in a pale to moderately dark brown transverse stripe, outermost spot small and rarely elongate (figs. 50 and 51) 11

11 Each dorsal lobe of disc with a larger triangular patch at base; each ventral lobe at base with dark spots larger and transverse stripe pale brown, tip with dark patch large and shaped as in fig. 50; larva brownish . . . . . **Nephrotoma quadrifaria** Meig. (p. 442)

– Each dorsal lobe of disc with a smaller and more irregular patch at base; each ventral lobe at base with dark spots smaller and transverse stripe moderately dark brown, tip with dark patch small and variable in shape but usually as in fig. 51; larva greyish **Nephrotoma flavescens** L. (p. 444)

12 Spiracular disc with dorsal lobes short and broad, almost semi-circular in outline seen from behind, each with posterior surface convex, entirely heavily sclerotised and black, sclerotisation extending on to disc between spiracles as in fig. 56, with anterior surface flattened and unsclerotised except at edges; lateral and ventral lobes of disc with marginal hair fringe and extensive dark brown patches as in fig. 56; anal field with four slender anal papillae, lateral pair twice as long as breadth at base, ventral pair about as long as breadth at base (fig. 57); last abdominal segment with a pair of lateral protruberances and with dense bands of hairs, as in figs. 58 and 59 **Tipula variicornis** Schum. (p. 445)

— Spiracular disc not as above; each dorsal lobe sometimes with a broad black longitudinal stripe (*Tipula lunata* group), but these lobes then always conical with pointed or narrowly rounded tips (e.g. figs. 66 and 67) 13

13 Each dorsal lobe of disc with tip heavily sclerotised, sharply pointed and slightly curved anteriorly (figs. 70 and 71), posterior side of lobe with a broad black longitudinal stripe extending from tip on to disc between spiracles; lateral lobes moderately long and conical, each with a black median longitudinal stripe; ventral lobes short; glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes; marginal hair fringe absent; anal papillae reduced to four rounded lobes anterior to anus 14

— Each dorsal lobe of disc with tip not sclerotised nor sharply pointed, posterior side of lobe sometimes with a black longitudinal stripe extending from tip on to disc between spiracles (e.g. fig. 72), but tip always unsclerotised anteriorly and laterally 18

14 Each ventral lobe of disc with a broad brown or dark brown patch covering entire upper surface (fig. 66), patch sometimes paler in middle; width of unpigmented part of disc between patches on ventral lobes considerably less than greatest diameter of spiracle, usually about half this diameter; dorsal lobes shorter than lateral lobes and with black longitudinal stripes often joined at base as in fig. 66 . . . . . **Tipula lunata** L. (p. 451)

— Each ventral lobe of disc with upper surface partly or entirely pigmented, but width of unpigmented part of disc between patches on ventral lobes at least equal to, and usually considerably greater than, greatest diameter of spiracle; dorsal lobes as long as or shorter than lateral lobes but with black longitudinal stripes always clearly separated at base 15

15 Each ventral lobe of disc with pigmentation confined to a basal transverse row of three small dark spots in a narrow pale stripe, and a dark brown patch that extends from tip about half-way along inner margin; each lateral lobe with longitudinal stripe only half as wide as plate of spiracle, and confined to basal half of lobe; anus separated from anal papillae by a narrow pigmented band (fig. 61) . . . . . **Tipula scripta** Meig. (p. 445)

— Each ventral lobe of disc with pigmentation more extensive, inner or outer margin with a pale or dark brown stripe that is continuous with a moderately large dark brown patch at base of lobe, or entire upper surface pigmented; each lateral lobe with longitudinal stripe at least as wide as plate of spiracle and always extending on to apical half of lobe, sometimes almost to tip; no pigmented band between anus and anal papillae 16

16 Each ventral lobe of disc about as long as breadth at base, with entire upper surface pigmented, dark brown at base and tip, brown between; each lateral lobe with longitudinal stripe sometimes extending almost to tip (fig. 67) . . . **Tipula selene** Meig. (p. 452)

— Each ventral lobe of disc about half as long as breadth at base, upper surface not entirely pigmented (figs. 68 and 69) 17

17 Each ventral lobe of disc pigmented as in fig. 68, wedge-shaped patch at base dark brown with two blackish spots in broader inner part, stripe on inner margin pale brown, outer margin unpigmented, patch at tip dark brown; each lateral lobe with longitudinal stripe black for basal two-thirds and very pale brown for apical third; dorsal lobes shorter than lateral lobes . . . **Tipula cava** Riedel (p. 454)

— Each ventral lobe of disc pigmented as in fig. 69, oval patch at base moderately dark brown with two blackish spots, tip and marginal stripes brown or moderately pale brown; each lateral lobe with longitudinal stripe entirely black; dorsal lobes almost or quite as long as lateral lobes . . . . . **Tipula brevispina** Pierre (p. 456)

18 Anal papillae reduced to four rounded protuberances, each scarcely half as long as breadth at base; spiracular disc without marginal hair fringe (except in *Ctenophora pectinicornis*, fig. 47); glabrous area of disc extending on to ventral lobes but not on to dorsal or lateral lobes; lateral lobes longer than dorsal lobes . . . 19

— At least one pair of anal papillae as long as or longer than breadth at base; spiracular disc with marginal hair fringe; glabrous area of disc extending on to ventral lobes and on to at least basal half of each dorsal and (except in *Tipula unca*, fig. 89) lateral lobe 25

19 Each dorsal lobe of disc with a tapering longitudinal stripe extending from tip on to disc between spiracles (fig. 72), stripe black at tip and progressively paler below; each lateral lobe with a dark brown to black moderately broad longitudinal stripe; each ventral lobe extensively pigmented as in fig. 72, with spot at base black and apical part dark brown or black, otherwise pale brown **Tipula vernalis** Meig. (p. 457)

— Each dorsal lobe of disc with at least apical half unpigmented, dark brown or black stripe or patch confined to basal half or extreme base of lobe 20

20 Dorsal and lateral lobes of disc each with a dark stripe or patch on basal half of lobe; each lateral lobe with a short longitudinal black stripe; larvae *either* greyish in decaying wood *or* grey-brown or brown in soil and leaf mould 21

— Dorsal and lateral lobes of disc each with a dark stripe or patch at extreme base but not on lobe itself; each lateral lobe with stripe or patch elongate transverse to long axis of lobe; larvae whitish in decaying wood 24

21 Each ventral lobe of disc with pigmentation confined to a basal transverse row of three small black spots joined by a very narrow brown or pale brown stripe, and a small dark brown patch at tip, inner margin usually very pale brown towards tip (fig. 60); each lateral lobe with longitudinal stripe less than half as wide as plate of spiracle; anus separated from anal papillae by a narrow pigmented band **Tipula rubripes** Schum. (p. 448)

— Each ventral lobe of disc *either* entirely dark brown or black *or* with two dark brown spots at base and apical half dark brown; each lateral lobe with longitudinal stripe more than half as wide as plate of spiracle; no pigmented band between anus and anal papillae . 22

22 Each lateral lobe of disc with longitudinal stripe wider than plate of spiracle (fig. 82); ventral lobes entirely dark brown or black; larva greyish, in moss and debris on decaying wood **Tipula irrorata** Macq. (p. 464)

— Each lateral lobe of disc with longitudinal stripe never wider and usually clearly narrower than plate of spiracle (fig. 86); ventral lobes partly or entirely dark brown or black; larvae greyish- or reddish-brown, in leaf mould and soil 23

23 Each ventral lobe of disc entirely dark brown or black (fig. 86); larva reddish-brown . . . . . **Tipula hortulana** Meig. (p. 466)

— Each ventral lobe of disc with two dark brown spots at base and a dark brown broad crescentic or semi-circular patch on apical half, otherwise very pale brown (fig. 88); larva greyish-brown **Tipula variipennis** Meig. (p. 467)

24 Spiracular disc with marginal hair fringe, hairs short; each ventral lobe with a dark brown, broad, V-shaped stripe extending along inner and outer margins, apical end of stripe with an unpigmented spot from which arises a long seta; each lateral lobe with a dark brown, broad, almost semi-circular patch at base; each dorsal lobe with a dark brown, large, oval patch at base (fig. 47) **Ctenophora pectinicornis** L. (p. 439)

— Spiracular disc without marginal hair fringe, occasional specimens with a few hairs at bases of dorsal lobes and on or between ventral lobes; ventral lobes each with a brown crescentic stripe on outer margin, apical end of stripe with no unpigmented spot or long seta, inner margin unpigmented; each lateral lobe with a brown, moderately narrow, crescentic stripe at base; each dorsal lobe with a brown triangular patch at base (fig. 42) . **Dictenidia bimaculata** L. (p. 435)

25 One pair of anal papillae (lateral pair) about as long as breadth at base, conical with pointed tips; ventral pair reduced to rounded protuberances (figs. 90 and 92) 26

— Two or more pairs of anal papillae as long as or longer than breadth at base 27

26 Spiracular disc as in fig. 89; dorsal lobes about half as long and thick as lateral lobes, both pairs conical; ventral lobes about half as long as lateral lobes, clearly separated at base; glabrous area of disc extending to tips of ventral lobes, on to basal half of each dorsal lobe, but not on to lateral lobes; hairs of marginal fringe short; all pigmented patches on disc dark brown . . . **Tipula unca** Wied. (p. 468)

— Spiracular disc as in fig. 91 ; dorsal and lateral lobes of almost equal length and thickness, conical only at tips ; ventral lobes as long as lateral lobes, touching at base ; glabrous area of disc extending to tips of ventral lobes, onto greater part of each dorsal lobe, and onto basal half of each lateral lobe ; hairs of marginal fringe moderately long ; each dorsal lobe with very pale brown to brown marginal stripes, each lateral lobe with a brown stripe on lower margin, each ventral lobe at base with two dark brown or black spots in a paler brown patch that extends to both margins of lobe, tip with a dark brown pyriform patch . . . . . **Tipula oleracea** group (*T. oleracea* L., *T. paludosa* Meig. (p. 468), and *T. czizeki* De Jong)

27 Eight anal papillae 28

— Four or six anal papillae 32

28 All anal papillae short or very short, arranged in two transverse rows of four (figs. 97 and 98) 29

— Four anal papillae long and slender and four very short (fig. 75) . . 31

29 Spiracular disc with dorsal and lateral lobes as long and broad as ventral lobes (figs. 94 and 96) ; each lobe about one-and-a-half times as long as breadth at base, scarcely tapered in at least basal half ; glabrous area of disc extending to tips of all lobes ; hairs of marginal fringe long at bases of lobes and very long near tips of lobes (fig. 94) ; anal field as in fig. 97 ; larva with dorsum and pleura dark brown with two pale dorsal longitudinal stripes and numerous pale spots and streaks (fig. 95), venter pale grey-brown **Tipula cheethami** Edw. (p. 475)

— Spiracular disc with lateral and especially dorsal lobes shorter and narrower than ventral lobes (figs. 99 and 100) ; ventral lobes not longer than breadth at base ; all lobes clearly tapered from base to tip ; hairs of marginal fringe short or only moderately long, not noticeably longer at tips of lobes than at their bases ; anal field as in fig. 98 ; larvae either entirely pale grey-brown or with only dorsum (not pleura) darkened with pale longitudinal stripes . . 30

30 Larva with dorsum distinctly darkened, grey-brown, with a slightly darker median longitudinal stripe bordered on each side by a pale interrupted stripe ; pleura and venter pale grey-brown ; spiracular disc (fig. 99) with glabrous area extending almost to tips of lateral lobes ; each lateral lobe with a dark brown stripe on lower margin and a pale grey-brown stripe on upper margin ; each ventral lobe with broad grey-brown marginal stripes separated from brown median apical stripe by paler orange-brown areas **Tipula rufina** Meig. (p. 472)

— Larva entirely pale grey-brown, dorsum unstriped ; spiracular disc (fig. 100) with glabrous area extending on to basal half of each lateral lobe ; each lateral lobe with a dark brown stripe on lower margin, upper margin unpigmented ; each ventral lobe with broad brown or dark brown marginal stripes continuous with a dark brown or a black median apical stripe . . . **Tipula marmorata** Meig. (p. 474)

31 Pleuron of each of abdominal segments two to seven with seta L3 close to L1 and L2 (fig. 76) ; each ventral lobe of spiracular disc (fig. 73) with a moderately large oval black spot at base, spot in a large brown or dark brown patch that extends to base of outer margin ; outer margin otherwise unpigmented ; inner margin with a moderately broad brown stripe that does not reach dark patch at tip ; dark patch at tip with black median stripe not bifurcate at base;

each lateral lobe with upper margin unpigmented, lower margin with a brown stripe . . . . . **Tipula maxima** Poda (p. 458)

— Pleuron of each of abdominal segments two to seven with seta L3 far from L1 and L2 (fig. 77) ; each ventral lobe of spiracular disc (fig. 74) with a small oval black spot at base, spot in a small pale or very pale brown patch that does not extend to base of outer margin ; inner and outer margins each with a narrow pale brown stripe that reaches dark patch at tip ; dark patch at tip with black median stripe usually bifurcate at base ; each lateral lobe with a usually pale brown stripe on lower margin, upper margin often with a very pale brown stripe on basal half . . . **Tipula fulvipennis** Deg. (p. 460)

32 Dorsum of last abdominal segment clothed with moderately long pubescence and with two pairs of small rounded protuberances each covered by a dense tuft of very long hairs ; first pair latero-dorsal at middle of segment (fig. 110), second pair dorsal immediately anterior to dorsal and lateral lobes of spiracular disc and with hair tuft as long as these lobes (fig. 109) ; all lobes of disc short with rounded tips, each lateral lobe with an apical tuft of long hairs, dorsal lobes without such tufts (fig. 106) ; six anal papillae as in figs. 106 and 110, posterior pair scarcely longer than breadth at base . . . . . **Tipula pruinosa** Wied. (p. 479)

— Dorsum of last abdominal segment clothed with short or very short pubescence and without protuberances ; sometimes with a very small dense tuft of short hairs immediately anterior to lateral lobes of spiracular disc but hairs many times shorter than these lobes ; all lobes of disc long, *either* lateral lobes without apical tufts of hair *or* both lateral and dorsal lobes with apical tufts of short hairs ; four or six anal papillae ; if six, all are three or more times longer than breadth at base 33

33 Dorsum brown or grey-brown, distinctly darker than pleura and venter, with a darker narrow median longitudinal stripe bordered on each side by a narrow pale stripe (fig. 102) ; venter and usually pleura pale greyish-brown, pleura sometimes darkened ; dorsal and lateral lobes of spiracular disc without apical hair tufts, each with pale or very pale brown marginal stripes ; each ventral lobe with base and margins extremely pale brown, with two small dark brown spots at base and a narrow median longitudinal stripe that is brown near tip and pale brown near base (fig. 101) ; with four or six anal papillae 34

— Dorsum not or scarcely darker than pleura and venter, without longitudinal stripes, larvae brown or grey-brown ; each dorsal and lateral lobe of spiracular disc with a small apical tuft of short hairs, and with distinct brown marginal stripes ; each ventral lobe with extensive brown or dark brown areas, median longitudinal stripe confined to apex of lobe ; four anal papillae 35

34 Four anal papillae as in fig. 104 . . **Tipula solstitialis** Westh. (p. 476)

— Six anal papillae as in figs. 103 and 105 . . **Tipula lateralis** Meig. (p. 477)

35 Each ventral lobe of disc (fig. 78) with a broad ∧-shaped dark brown to black stripe across base and a dark brown or black pyriform patch at tip, otherwise unpigmented ; each dorsal lobe with moderately broad brown marginal stripes, outer stripe shorter and usually paler than inner ; each lateral lobe with a moderately broad brown stripe on lower margin and a small pale brown patch at base of upper margin ; anal papillae stout, scarcely longer than breadth at base (fig. 79) . . . . . **Tipula vittata** Meig. (p. 461)

— Each ventral lobe of disc (fig. 80) with base, margins, and tip broadly reddish-brown, with only a small area at middle unpigmented; base with a short transverse black stripe, tip with a short longitudinal black stripe; each dorsal lobe with very broad reddish-brown marginal stripes of equal length; each lateral lobe with a broad reddish-brown stripe on each margin, stripe on upper margin sometimes extremely pale or absent near tip; anal papillae moderately slender, postero-lateral pair about twice as long as breadth at base (fig. 81) . . . . . **Tipula luna** Westh. (p. 463)

VI. Descriptions of Larvae.

In the descriptions which follow, the lengths and breadths given are those of the largest specimens that I have seen.

Genus *Dolichopeza* Curtis.

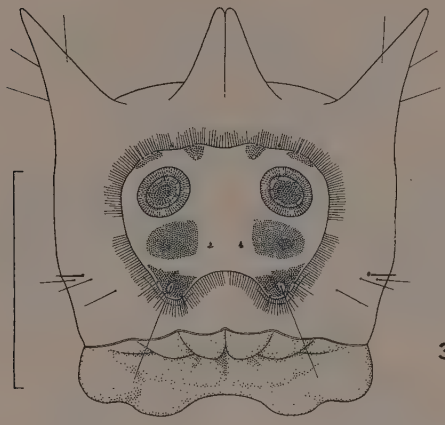
Dolichopeza albipes Stroem. (Figs. 1–5, 37–39).

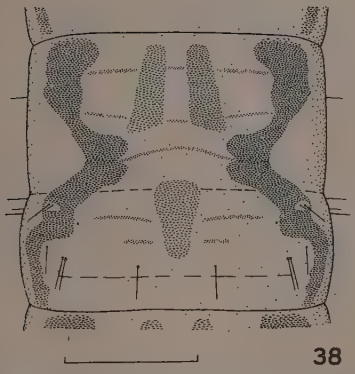
Last instar larva.—Length, 15 mm.; breadth, 2 mm. Moderately dark green; dorsal side, except on first and last segments, with a pair of dark brown longitudinal zig-zag stripes, each of abdominal segments two to seven with three pale brown patches between the dark stripes (fig. 38); pleura and ventral side without stripes or patches. Pubescence dense, generally very short and adpressed but with longer, erect hairs arranged in a number of narrow transverse bands on dorsal side of each segment. *Spiracular disc* (fig. 37): dorsal and lateral lobes conical with pointed tips; dorsal lobes with median surfaces touching, shorter than lateral lobes; lateral lobes nearly twice as long as breadth at base; ventral lobes not as long as breadth at base, tips rounded. Glabrous area of disc extending on to ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe present, hairs moderately short. Each dorsal lobe at base with a small triangular moderately dark brown patch; with a single seta above patch at level of marginal fringe. Each lateral lobe at base with a small, transversely elongate, moderately dark brown patch; with two setae above patch at level of marginal fringe. A single seta arises between each dorsal and lateral lobe above marginal fringe. Each ventral lobe with a large, almost rectangular, brown to dark brown patch at base, and with an almost semi-circular dark brown to black patch extending over greater part of upper side of lobe itself; with a very long slender seta arising from an unpigmented oval area near apex of patch and with four shorter setae arising between patch and hair fringe, as in fig. 37. Spiracles oval; plate golden brown, stigmatic scar dark brown with periphery often paler, as in fig. 37. *Anal field*: glabrous; marginal band pale to dark brown; anal papillae represented by four rounded lobes anterior to anus (fig. 39).

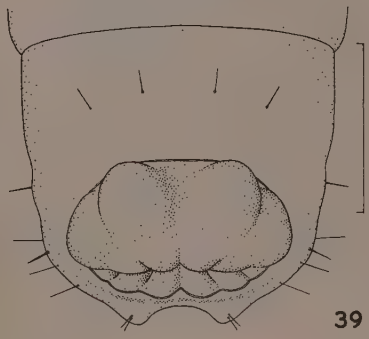
Distribution.—Generally distributed. Frequent in damp woods.

Comparative notes.—The larvae differ from those of all other Tipulinae in that the dorsal lobes of the spiracular disc are very close together. This feature, together with the presence of the dark, dorsal, zig-zag stripes and the distinctly green general colour, makes for easy recognition of the larvae.

Habits.—The larvae usually live in, and feed on, mosses in moist or wet places, usually in woods. Pupation occurs in the moss. Beling (1886) found a larva in soil on a grassy path in a spruce wood, and suggested that mosses are not essential as larval food.







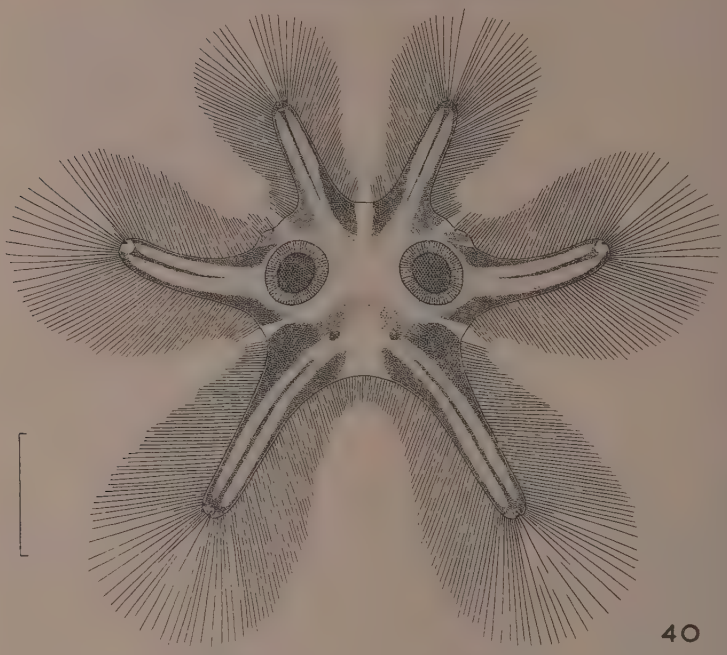
FIGS. 37–39.—*Dolichopeza albipes* Stroem. (37) Posterior view of last abdominal segment. (38) Dorsal view of fifth abdominal segment. (39) Ventral view of last abdominal segment.

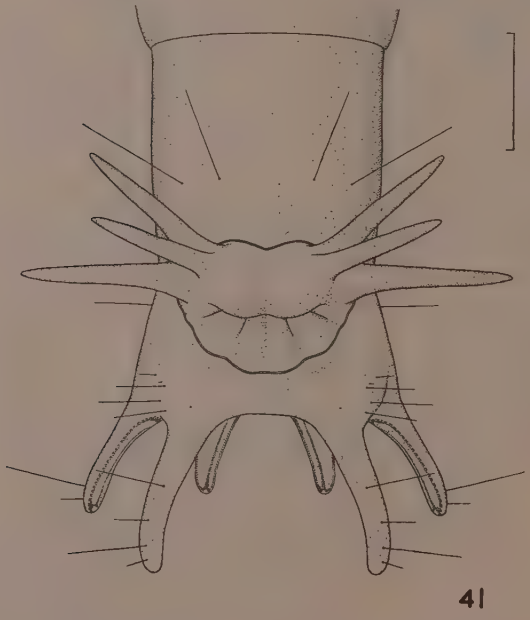
Genus *Prionocera* Loew.

The larvae of this genus are characterised by the very long and slender lobes of the spiracular disc. The lobes are fringed with very long hairs, and on the posterior surface of each there are heavily pigmented marginal and median longitudinal stripes. There are six long and slender anal papillae.

Prionocera turcica Fabricius. (Figs. 6–9, 40–41).

Last instar larva.—Length, 35 mm.; breadth, 3 mm. Cuticle unpigmented; clothed with dense short silky pubescence that is slightly longer on first four segments. Dorsal side grey with small inconspicuous paler streaks and patches, some specimens with a slightly darker inconspicuous interrupted median longitudinal stripe; pleura and ventral side pale grey. *Spiracular disc* (fig. 40): all lobes very long and slender, between three and four times





FIGS. 40–41.—*Prionocera turcica* Fabricius. (40) Spiracular disc. (41) Ventral view of last abdominal segment.

as long as breadth at base, with posterior surfaces flattened ; ventral lobes longest, dorsal lobes shortest (about two-thirds length of ventral lobes), lateral lobes intermediate in length. Glabrous area of disc extending to tips of all lobes. Hairs of marginal fringe very long. Disc with pigmented areas, as in fig. 40 ; each lobe pale or very pale brown with median and marginal stripes dark brown or black (except for broader basal part of outer marginal stripe on each dorsal lobe which is brown or rather pale brown) ; median -∧shaped patch on disc between ventral lobes pale to moderately dark brown. Disc with sensory setae arising just inside hair fringe as follows : tip of each dorsal lobe with a very short seta ; tip of each lateral lobe with two short setae very close together ; each side between dorsal and lateral lobe with two short setae at dorsal edge of small brown patch ; tip of each ventral lobe with a long slender seta arising from an unpigmented spot and with four other setae arising between pigmented area and hair fringe, as in fig. 40. Spiracles slightly oval ; plate brown or dark brown, stigmatic scar black. *Anal field* : marginal band brown or dark brown. Six long and slender anal papillae anterior to anus (fig. 41), antero-ventral pair shorter than antero-lateral pair and posterior pair.

Distribution.—Generally distributed. Frequent on moors.

Comparative notes.—The larvae are not likely to be confused with those of any of the other British genera, from which they can be distinguished by the characters given in the key. The larvae of the other two British species of *Prionocera*, *P. proxima* Lack. and *P. pubescens* Loew, are unknown, but the larva of a Nearctic species, *P. fuscipennis* Loew, has been described by Alexander (1920). From his figure 502 it is clear that the spiracular disc of *P. fuscipennis* is very similar to that of *P. turcica* but differs from it in the precise extent of the pigmented stripes and lacks the small brown patch that in *P. turcica* is present just above the base of the dorsal marginal stripe on each lateral lobe. It may therefore be possible to distinguish the larvae of the species of *Prionocera* on differences in the shape and extent of the pigmentation of the spiracular disc.

Habits.—I have found larvae in one locality only—in saturated soil among roots of *Juncus* at the edge of a moorland pond (Near Priddy, Somerset).

Genus *Dictenidia* Brullé.

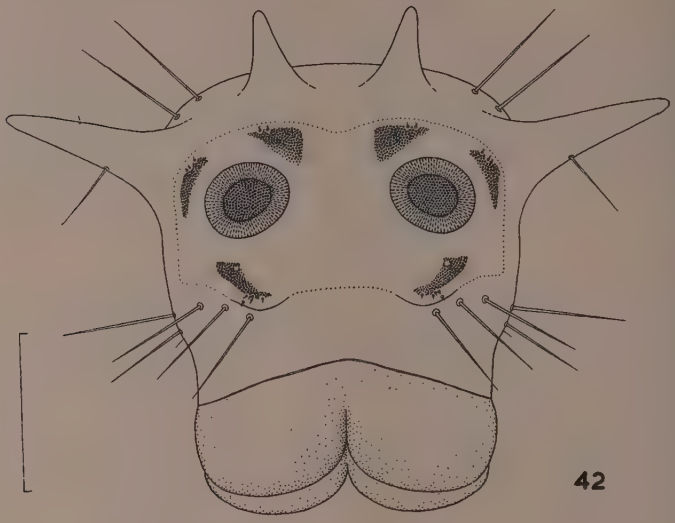
Dictenidia bimaculata L. (Figs. 10–14, 42–43).

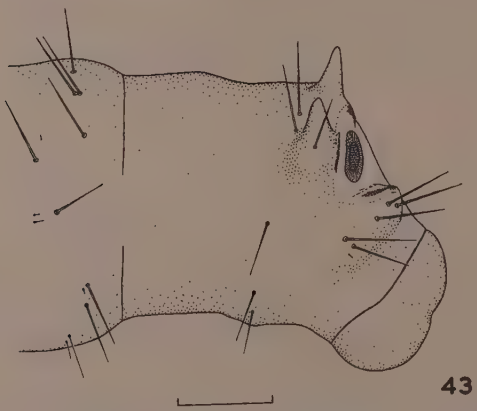
Last instar larva.—Length, 33 mm.; breadth, 4 mm. Cuticle unpigmented, clothed with pale yellowish-brown pubescence that is largely very short and inconspicuous but is slightly longer on thoracic segments and on dorsal side of last segment. *Spiracular disc* (fig. 42) : dorsal and lateral lobes elongate and conical with pointed or narrowly rounded tips, lateral lobes about twice as long and thick as dorsal lobes ; ventral lobes extremely short (fig. 43), scarcely half as long as breadth at base. Glabrous area of disc not extending on to dorsal or lateral lobes ; marginal hair fringe normally absent, occasional specimens with a few hairs at base of each dorsal lobe and on or between ventral lobes. All pigmented stripes and patches on disc usually moderately dark brown. Each dorsal lobe at base with a triangular patch ; two very short, frequently bifid, setae at dorsal edge of patch. Each lateral lobe at base with a crescent-shaped stripe transverse to long axis of lobe ; with three very short, frequently bifid, setae at outer dorsal edge of stripe. Each ventral lobe with a curved wedge-shaped stripe extending along outer margin ; stripe broadest at base ; tip of lobe beyond stripe with six very short setae, as in fig. 42. Spiracles large and oval ; plate pale brown or brown, stigmatic scar dark brown or black. *Anal field :* glabrous, borne at end of a short ' peduncle "[8] (fig. 43) ; marginal band pale brown ; anal papillae represented by four rounded lobes, two on each side of anus.

[8] See general discussion of anal field.

Distribution.—Generally distributed. Frequent in damp woods.

Comparative notes.—The larva is only liable to be confused with that of *Ctenophora pectinicornis* L., but can be distinguished from it by means of the





Figs. 42–43.—*Dictenidia bimaculata* L., last abdominal segment. (42) Posterior view. (43) Side view.

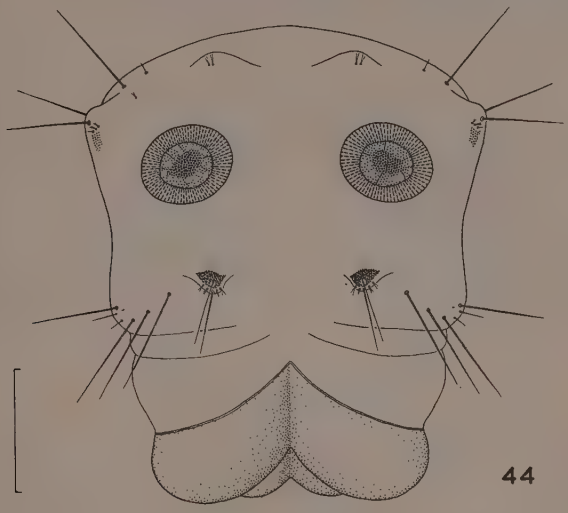
characters given in the key. In *C. pectinicornis* the pubescence is slightly longer and more conspicuous than it is in *D. bimaculata*, but the setae are shorter and more slender than those of the latter.

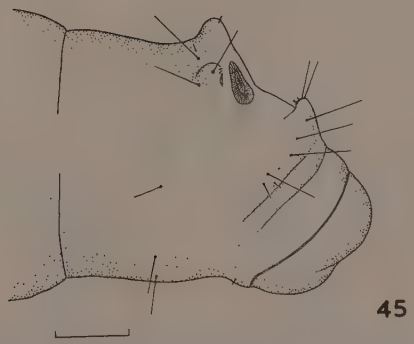
Habits.—The larvae live in decaying wood.

Genus *Tanyptera* Latreille.

Tanyptera atrata L. (Figs. 15–18, 44–45).

Last instar larva.—Length, 40 mm.; breadth, 7 mm. Cuticle unpigmented ; glabrous and shining except for anterior part of prothorax, which is clothed with very short, adpressed, silky, pale brown pubescence. *Spiracular disc* (fig. 44) : all lobes of disc are extremely short





Figs. 44–45.—*Tanyptera atrata* L., last abdominal segment.
(44) Posterior view. (45) Side view.

rounded protuberances. Marginal hair fringe absent. Dorsal lobes without pigmented patches ; each with two very short, usually bifid or trifid, setae on posterior surface near tip. Each lateral lobe with a small brown or pale brown patch on ventral margin ; three very short setae close to dorsal edge of patch, outer seta unbranched, inner two setae usually bifid ; tip of lobe with a long stout seta. Disc between each dorsal and lateral lobe with a very short usually bifid seta. Each ventral lobe with a small brown or dark brown apical

patch which sometimes extends a short distance along outer margin of lobe ; patch with a small unpigmented oval area from which arises a long slender seta ; extreme tip of lobe beyond patch with a second long, but stouter, seta and with four very short, usually bifid setae. Spiracles large and oval ; plate golden brown ; stigmatic scar dark brown or black at middle, otherwise pale brown (fig. 44). *Anal field* : glabrous, borne at end of a short " peduncle "[9] (fig. 45) ; marginal band pale brown ; anal papillae represented by four rounded lobes, two on each side of anus.

Third instar larva.—Length, 25 mm.; breadth, 3·0 mm. Entirely similar to last instar, apart from size.

Distribution.—Generally distributed. Frequent in damp woods.

Comparative notes.—The larva is unlikely to be confused with that of any of the other species described here. In the larva of *Ctenophora ornata* Meig., in which the lobes of the spiracular disc are also extremely short (fig. 46), there are extensive brown patches on the disc and a marginal hair fringe is present. In the larva of *Tipula flavolineata* Meig. the lobes of the disc are very short (fig. 65) but the dorsal and lateral pairs are pointed, not rounded as in *T. atrata*. Moreover, the arrangement of the setae on the lateral and ventral lobes of *T. flavolineata* larvae differs from that of *T. atrata* larvae, as described in the key.

Habits.—The larvae live in decaying, although often relatively sound, wood.

Genus *Ctenophora* Meigen.

Ctenophora ornata Meigen. (Fig. 46).

Last instar larva.—Length, 40 mm.; breadth, 5 mm. Cuticle unpigmented ; clothed with pale brown, short, fairly dense pubescence that is slightly longer on dorsal side, especially of last segment, than on pleura or ventral side. *Spiracular disc* (fig. 46) : all lobes of disc are extremely short, rounded protuberances ; lateral lobes slightly longer than dorsal lobes, ventral lobes broader at base than either dorsal or lateral lobes. Glabrous area of disc with marginal fringe of fairly short hairs extending on to basal halves of dorsal and ventral lobes but scarcely on to lateral lobes. Each dorsal lobe at base with a large orange-brown to pale yellow-brown patch, and with a very short seta at dorsal edge of patch just inside hair fringe. Each lateral lobe at base with a fairly large brown to moderately pale brown patch, and with a very short seta at dorsal edge of patch just inside hair fringe. Each ventral lobe at base with two dark brown spots in a larger brown patch ; margins of lobe broadly pale to very pale yellow-brown ; tip with a short, dark brown, median longitudinal stripe that ends in an unpigmented oval area from which probably[10] arises a long seta ; three very short setae arise between pigmented areas and hair fringe, as in fig. 46. Spiracles large and slightly oval ; plate pale orange-brown ; stigmatic scar black at middle, orange-brown elsewhere. *Anal field* : marginal band brown ; anal papillae represented by four rounded lobes, two on each side of anus.

Distribution.—Recorded from Staffs. (Cannock Chase), Berks. (Windsor Forest), Kent (Darenth), and Hants. (New Forest). In woods.

Comparative notes.—The larva can be distinguished from those of *Tanyptera atrata* and *Tipula flavolineata*, in which the dorsal and lateral lobes of the spiracular disc are also extremely short, by means of the characters given in the key.

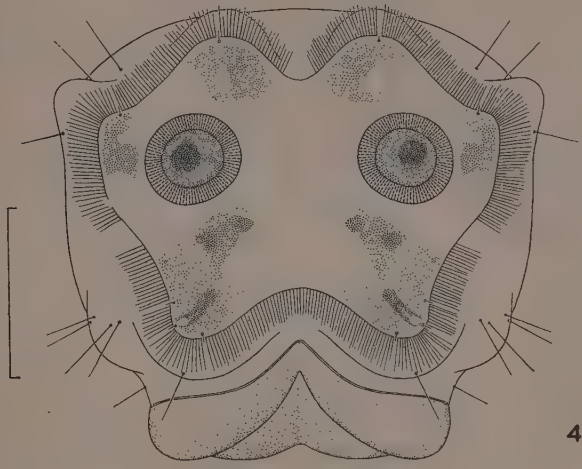
[9] See general discussion of anal field.

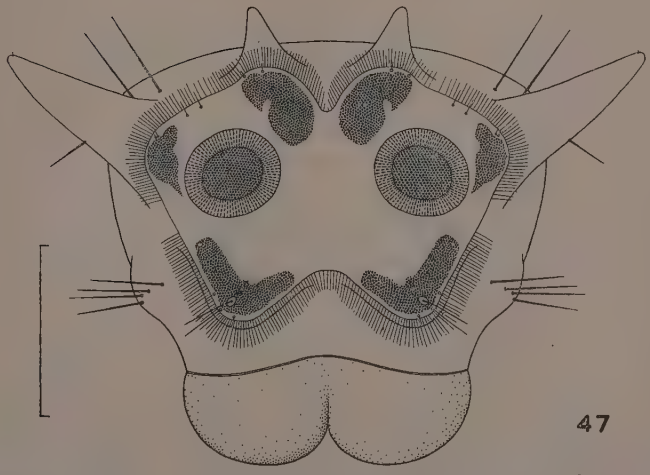
[10] In the only complete specimen available for examination, a setal socket is present on this oval area but the seta itself is missing.

Habits.—The larvae most probably live in decaying wood, although I have been able to find no definite record of this.

Ctenophora pectinicornis L. (Figs. 19–22, 47).

Last instar larva.—Length, 30 mm.; breadth, 4·5 mm. Cuticle unpigmented; clothed with pale brown, short, fairly dense pubescence that is slightly longer and denser on dorsal side of last two or three segments, especially the last, and is shortest on pleura. *Spiracular disc* (fig. 47): dorsal and lateral lobes conical, with pointed or narrowly rounded tips; lateral lobes about twice as long and thick as dorsal lobes. Ventral lobes short, about half





Figs. 46–47.—(46) Posterior view of last abdominal segment of *Ctenophora ornata* Meig. (47) Same of *C. pectinicornis* L.

as long as breadth at base, with rounded tips. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes ; with marginal fringe of short hairs. Each dorsal lobe at base with a large, dark brown, oval patch, and with two very short setae immediately beyond edge of patch just inside hair fringe. Each lateral lobe at base with a moderately large, dark brown, almost semi-circular patch, and with two very short setae close together immediately beyond dorsal edge of patch just inside hair fringe. Two short setae arise inside hair fringe between each dorsal and lateral lobe. Each ventral lobe with broad, dark brown marginal stripes that are continuous at tip and form a distinct V-shaped patch ; apex of V with an unpigmented oval area from which arises a long, slender seta ; three other setae, the middle one long and the other two short, arise near tip of lobe between pigmented patch and hair fringe, as in fig. 47. Spiracles large and slightly oval ; plate yellowish-brown, stigmatic scar dark brown or black. *Anal field* : marginal band dark brown ; anal papillae represented by four rounded lobes, two on each side of anus.

Distribution.—Generally distributed. Frequent in woods.

Comparative notes.—The larva can be readily distinguished from that of *C. ornata* by the greater length of the dorsal and lateral lobes of the spiracular disc. The pigmented patches on the discs of the two species are of generally similar shape, but they are much darker in *pectinicornis* than in *ornata*, and the basal pigmentation on the ventral lobes of the latter species is not present in *pectinicornis*.

Habits.—The larvae live in decaying wood.

Genus *Nephrotoma* Meigen.

The larvae of this genus are characterised by the presence of a pair of raised welts or pads on the dorsal side of the prothorax (fig. 55), and they possess the following characters :

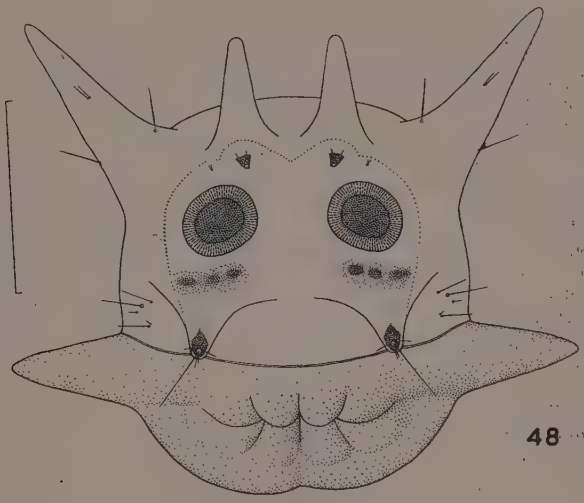
Cuticle unpigmented, clothed with short or very short pubescence that is transversely banded on dorsal and ventral sides of all segments except, usually, first and last ; pleura not banded. *Spiracular disc* : dorsal and lateral lobes conical with pointed or narrowly rounded tips ; lateral lobes about twice as long as breadth at base, almost twice as long and thick as dorsal lobes ; ventral lobes short, about as long as breadth at base. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes ; marginal hair fringe absent. Each dorsal lobe at extreme base with two very short unbranched or bifid setae and a minute circular plate, probably sensory ; setae and plate forming an inverted triangle just inside margin of glabrous area of disc (e.g. fig. 49) ; some species with a triangular pigmented patch between setae and plate, its ventral apex surrounding plate and its dorsal side partially or entirely surrounding setae (e.g. fig. 50). A very short unbranched or bifid seta arises between each dorsal and lateral lobe and on, but near edge of, glabrous area of disc. Lateral lobes without pigmented patches. *Anal field* with four anal papillae anterior to anus ; ventral papillae always reduced to rounded protuberances, lateral papillae never more than twice as long as breadth at base.

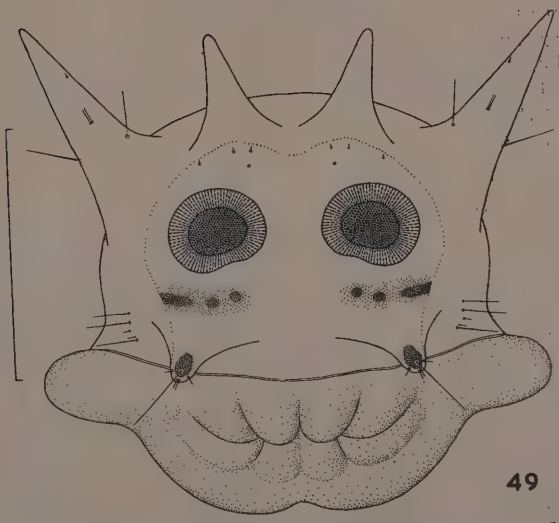
Nephrotoma flavipalpis Meigen. (Fig. 49).

Last instar larva.—Length, 20 mm.; breadth, 2·5 mm. Cuticle clothed with greyish or greenish-brown, dense, very short pubescence that is longer on dorsal side of last one or two segments. *Spiracular disc* (fig. 49) : dorsal lobes without pigmented patches. Each ventral lobe about as long as breadth at base, with moderately narrow, rounded tip ; base with a transverse row of three dark brown or black spots in a pale brown transverse stripe, outer spot elongate ; tip with a small, oval or pyriform, dark brown or black patch in which is a small unpigmented spot from which arises a long slender seta ; four short setae arise

at tip of lobe beyond dark patch, as in fig. 49. Spiracles oval, greatest diameter 0·37–0·38 mm., ventral margin usually notched or flattened, as in fig. 49; plate brown, stigmatic scar dark brown or black. *Anal field*: marginal band brown or dark brown; lateral anal papillae very short and rounded, scarcely longer than breadth at base.

Third instar larva.—Length, 10 mm.; breadth, 1·5 mm. Apart from size, differs from last instar only in that ventral lobes of spiracular disc are relatively slightly shorter and stigmatic scar of spiracle is not entirely black, but is brown peripherally. Greatest diameter of spiracle 0·19–0·20 mm.





FIGS. 48–49.—(48) Posterior view of last abdominal segment of *Nephrotoma analis* Schummel. (49) Same of *N. flavipalpis* Meigen.

Distribution.—Generally distributed. Common.

Comparative notes.—The larva can be distinguished from those of *N. analis*, *N. quadrifaria* and most larvae of *N. flavescens* by the absence of a brown patch at the base of each dorsal lobe of the spiracular disc. A few larvae of *N. flavescens* lack this patch but they are not likely to be confused with larvae of *N. flavipalpis* (see *N. flavescens*).

Habits.—The larvae live in wet to fairly dry soil.

Nephrotoma analis Schummel. (Figs. 48, 54).

Last instar larva.—Length, 19 mm.; breadth, 2·5 mm. Cuticle clothed with greenish-grey, dense, very short pubescence that is longer on dorsal side of last one or two segments and is slightly less dense on abdominal pleura than elsewhere. *Spiracular disc* (fig. 48): each dorsal lobe at base with a small, more or less triangular dark brown or black patch; dorsal edge of patch partially or entirely surrounding bases of setae and ventral apex usually surrounding sense-plate; setae usually unbranched, sometimes bifid. Seta between each dorsal and lateral lobe usually bifid. Each ventral lobe about as long as breadth at base, with narrow rounded tip; base with a transverse row of three dark brown or black spots in a pale grey transverse stripe, outer spot elongate and inner two spots sometimes confluent; tip with a small, oval or pyriform, dark brown or black patch in which is an unpigmented spot from which arises a long slender seta; four short setae arise at tip of lobe beyond dark patch, as in fig. 48. Spiracles oval, greatest diameter 0·37–0·38 mm.; plate brown, stigmatic scar usually entirely dark brown or black. *Anal field*: marginal band brown or dark brown; lateral anal papillae conical and pointed, nearly twice as long as breadth at base.

Distribution.—Generally distributed. Uncommon.

Comparative notes.—The lateral anal papillae are nearly twice as long as those of *N. flavipalpis*, *N. quadrifaria* and *N. flavescens*. In addition, the larva differs from those of the two latter species as follows: (1) the ventral lobes of the spiracular disc are more slender and are slightly longer, and (2) one of the five setae on each ventral lobe is very long. The brown patch at the base of each dorsal lobe is usually slightly smaller than in *N. quadrifaria*. The ventral lobes of the larva of *N. flavipalpis* are broader at the tip than are those of *N. analis*, but the lobes are otherwise similar.

Habits.—The larvae live in fairly moist soil.

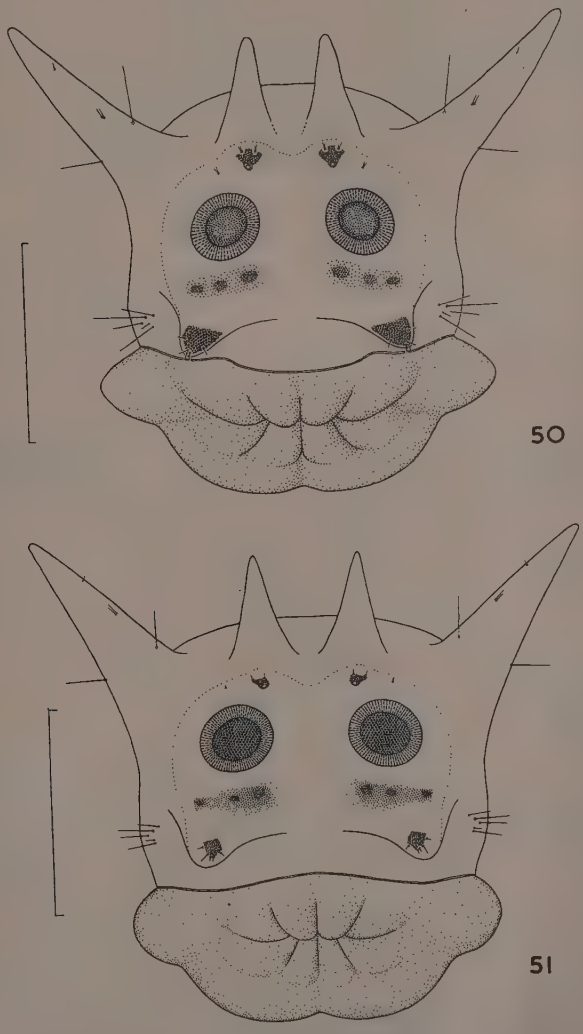
Nephrotoma quadrifaria Meigen. (Figs. 23–27, 50, 52–53, 55).

Last instar larva.—Length, 20 mm.; breadth, 2·5 mm. Cuticle clothed with brownish, dense, moderately short pubescence that is very short on first two segments and is slightly longer on dorsal side, especially on last one or two segments, than on pleura and ventral side. *Spiracular disc* (fig. 50): each dorsal lobe at base with a small, usually triangular, dark brown or black patch; dorsal side of patch partially (fig. 50) or entirely surrounding bases of setae, which are bifid or trifid; ventral apex of patch surrounding sense plate. Each ventral lobe about two-thirds as long as breadth at base, with rather broad, rounded tip; base with a transverse row of three dark brown or black spots in a pale brown transverse stripe, outer spot usually no larger than inner two; tip with a moderately large dark brown or black patch and with five short setae, as in fig. 50. Spiracles slightly oval, greatest diameter 0·35–0·36 mm.; plate brown, stigmatic scar either entirely dark brown, black, or largely reddish-brown, as in fig. 50. *Anal field*: marginal band brown or dark brown; lateral anal papillae rounded, scarcely longer than breadth at base (figs. 50, 53).

Third instar larva.—Length, 14 mm.; breadth, 2 mm.; greatest diameter of spiracle 0·17–0·18 mm. Differs from last instar only in size.

Distribution.—Generally distributed. Common.

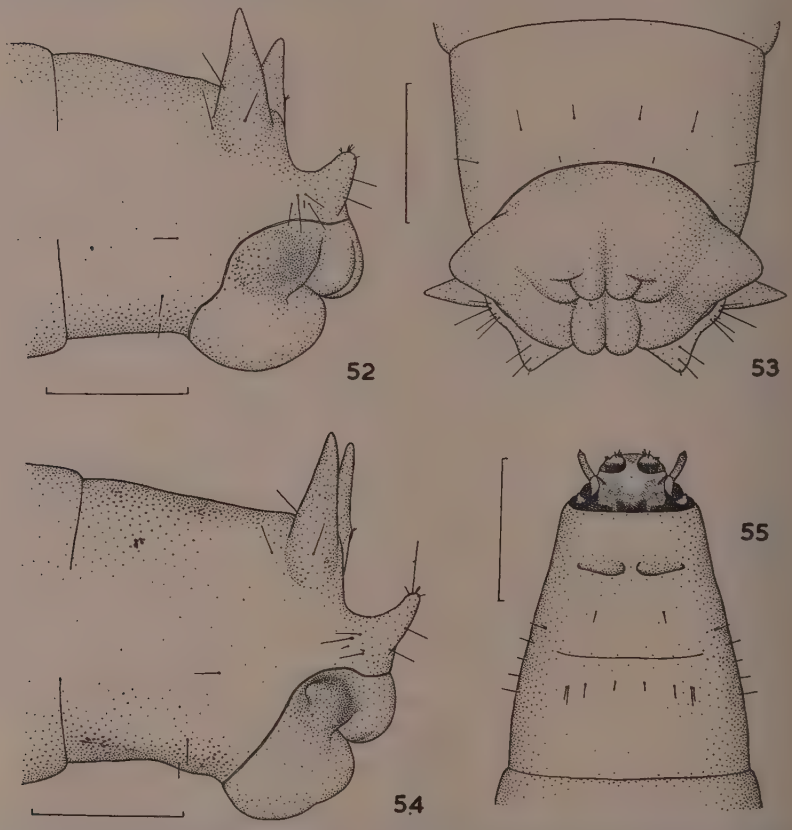
Comparative notes.—The larva is similar to that of *N. flavescens* but can be distinguished from it as shown in the key. The ventral lobes of the spiracular disc are shorter and broader than those of *N. flavipalpis* and *N. analis*, and the five setae at the tip of each ventral lobe are all short, whereas in the two latter



Figs. 50–51.—(50) Posterior view of last abdominal segment of *Nephrotoma quadrifaria* Meigen. (51) Same of *N. flavescens* L.

species one of the five is very long. Moreover, the pubescence is longer than that of the other three species described here, and it is brownish rather than greyish.

Habits.—The larvae live in wet or moderately dry soil. They have been bred from dried cow-dung (Coe, 1941), and from a decaying ash stump and a decaying *Digitalis* root (Beling, 1878).



Figs. 52–55.—(52) *Nephrotoma quadrifaria* Meigen, side view of last abdominal segment. (53) Same, ventral view. (54) *N. analis* Schummel, side view of last abdominal segment. (55) *N. quadrifaria* Meigen, dorsal view of prothorax showing raised welts.

Nephrotoma flavescens L. (Fig. 51).

Last instar larva.—Length, 20 mm.; breadth, 2·5 mm. Cuticle clothed with pale greyish-brown, dense, very short pubescence that is slightly longer on dorsal side of last segment. *Spiracular disc* (fig. 51): each dorsal lobe at base usually with a small, dark brown patch that is never larger than in fig. 51, but is frequently smaller or paler and is sometimes absent. Each ventral lobe about half as long as breadth at base, with broadly rounded tip; base with a transverse row of three very dark brown spots in a moderately broad, brown or

rather dark brown transverse stripe ; tip with a small dark brown patch and five short setae as in fig. 51 ; sometimes with a narrow, pale brown, median longitudinal stripe extending between stripe at base and patch at tip. Spiracles slightly oval ; plate brown, stigmatic scar either entirely black or with middle dark reddish-brown. *Anal field* : marginal band brown to black ; lateral anal papillae scarcely longer than breadth at base, tips rounded.

Distribution.—Generally distributed. Common.

Comparative notes.—The larva is rather similar to that of *N. quadrifaria* but can be distinguished from it as shown in the key. Some specimens of *N. flavescens* lack the dark patch at the base of each dorsal lobe, and, in this particular, thus resemble larvae of *N. flavipalpis*. The two species can always be distinguished, however, because the ventral lobes of *N. flavescens* are only half as long as their breadth at base and are broad at the tip, whereas those of *N. flavipalpis* are about as long as their breadth at base and are narrow at the tip. Furthermore, in *N. flavescens* all the setae at the tip of each ventral lobe are short, whereas in *N. flavipalpis* one of these setae is very long (cf. figs. 49 and 51).

Habits.—The larvae live in moist soil, usually under turf.

Genus *Tipula* L.

Tipula variicornis Schummel. (Figs. 56–59).

Last instar larva.—Length, 22 mm.; breadth, 2 mm. Cuticle unpigmented ; clothed with dense, very short, pale brownish pubescence. Last segment with a pair of small, rounded, lateral protuberances and with dense bands of long hairs laterally and dorsally, as in figs. 58 and 59. *Spiracular disc* (fig. 56) : each dorsal lobe about as long as breadth at base, almost semi-circular in outline seen from behind ; anterior side flattened and membranous except at raised and heavily sclerotised margins (fig. 58) ; posterior side convex except at margins, heavily sclerotised and black, sclerotisation extending on to disc between spiracles ; with a very short seta near tip, best seen in side view (fig. 59). Posterior surfaces of all lobes glabrous. Lateral and ventral lobes with marginal fringe of fairly long hairs and with extensive brown to black patches, as in fig. 56. Each lateral lobe with two short setae close together at tip between pigmented area and hair fringe, and with two similar setae at base of dorsal margin. Each ventral lobe with a long, slender seta arising from a conspicuous unpigmented spot in dark patch at tip, and with four short setae arising at tip between dark patch and hair fringe. Spiracles almost circular ; plate pale brown, stigmatic scar black. *Anal field* : marginal band dark brown ; four slender anal papillae (fig. 57) lateral pair about twice as long as breadth at base, ventral pair about half as long as lateral pair.

Distribution.—Generally distributed. Frequent.

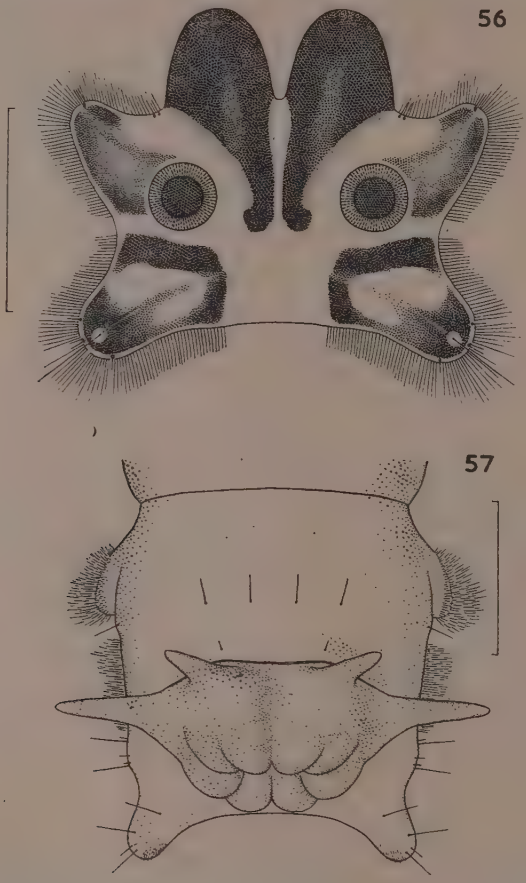
Comparative notes.—The spiracular disc is unlike that of any of the other species of Tipulinae known to me, and the larva is not likely to be confused with that of any other species described here. It seems probable, however, that the larva of *T. yerburyi* Edw., the adult of which resembles that of *T. variicornis* fairly closely, will be found to be similar.

Habits.—The larvae live in wet leaf mould or wet soil in marshy places or at the edges of ponds and streams, usually in woods.

Tipula scripta Meigen. (Fig. 61).

Last instar larva.—Length, 23 mm.; breadth, 3·5 mm. Cuticle unpigmented ; clothed with pale brown, dense, very short pubescence that is slightly longer on first three segments

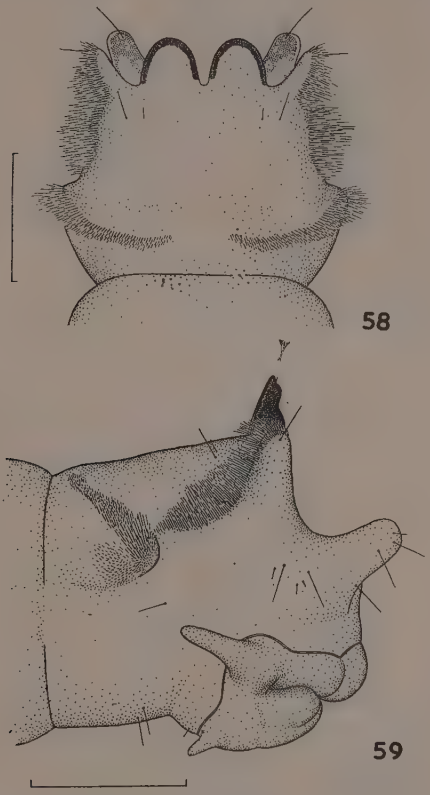
and on dorsal side of last segment. *Spiracular disc* (fig. 61): dorsal lobes conical, slightly longer than breadth at base, tips slender, pointed, and curved anteriorly; lateral lobes conical with narrowly rounded tips, about half as long again as dorsal lobes; ventral lobes about as long as breadth at base, with moderately narrow, rounded, upcurved tips. Glabrous area of disc extending to tips of ventral lobes and on to basal halves of dorsal



Figs. 56–57.—*Tipula variicornis* Schummel. (56) Spiracular disc. (57) Ventral view of last abdominal segment.

lobes but not on to lateral lobes. Marginal hair fringe absent. Each dorsal lobe with extreme tip entirely sclerotised and posterior surface with a black longitudinal stripe extending on to disc between spiracles, stripe narrow above and broad below, as in fig. 61; a very short seta arises immediately beyond outer edge of stripe near base of lobe. Another very short seta arises above spiracle on, but near edge of, glabrous area of disc. Each lateral lobe with a narrow, black, longitudinal stripe on basal half, and with two short setae very close together immediately beyond apical end of stripe. Each ventral lobe at base with a

row of three small dark brown or black spots in a narrow, pale brown, transverse stripe, as in fig. 61 ; tip with a dark brown or black patch extending along apical half of inner margin, outer margin unpigmented ; five short setae at tip of lobe, as in fig. 61. Width of unpigmented part of disc between patches on ventral lobes about one and a half times greatest diameter of spiracle. Spiracles slightly oval ; plate brown, stigmatic scar black. *Anal field* : marginal band brown or dark brown ; anal papillae represented by four



FIGS. 58–59.—*Tipula variicornis* Schummel, last abdominal segment.
(58) Dorsal view. (59) Side view.

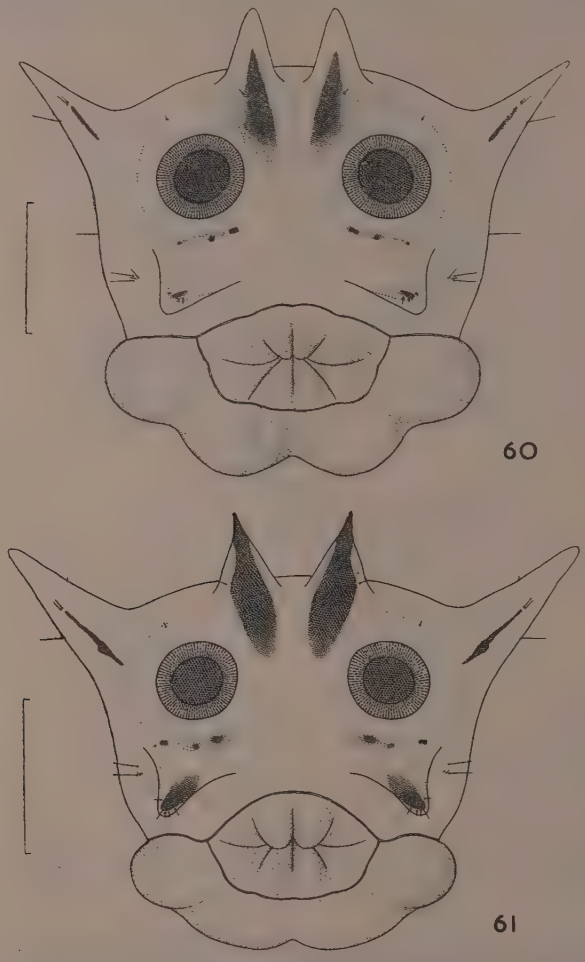
rounded lobes anterior to anus and separated from it by a narrow pigmented band similar to marginal band (fig. 61).

Distribution.—Generally distributed. Common.

Comparative notes.—Although this species is most conveniently included in the key in the *T. lunata* group, the larva differs from those of the other four species in the group as follows : (1) on the anal field there is an additional narrow pigmented band, similar to the usual marginal band, which separates the anus from the anal papillae ; (2) the longitudinal stripe on each lateral lobe of the disc is shorter and much narrower ; and (3) the pigmented patches on

each ventral lobe are much smaller. *T. scripta* and *T. rubripes* belong to the subgenus *Vestiplex*, whereas the four species of the *T. lunata* group belong to the subgenus *Lunatipula*.

Habits.—The larvae live in leaf mould or in moist soil in woods.



Figs. 60–61.—(60) Posterior view of last abdominal segment of *Tipula rubripes* Schummel. (61) Same of *T. scripta* Meigen.

Tipula rubripes Schummel. (Fig. 60.)

Last instar larva.—Length, 35 mm.; breadth, 4 mm. Cuticle unpigmented; clothed with pale brown, dense, very short pubescence that is slightly longer on first three segments and on dorsal side of last segment. *Spiracular disc* (fig. 60): dorsal and lateral lobes conical with pointed or narrowly rounded tips, each dorsal lobe slightly longer than breadth at base,

each lateral lobe from one-and-a-half times to twice as long as breadth at base ; each ventral lobe about as long as breadth at base, with rounded tip. Glabrous area of disc extending almost to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with a pigmented patch, as in fig. 60 ; part of patch is a tapering longitudinal stripe, black above and dark brown below, sometimes narrower than in fig. 60, always with a very short seta near its outer edge at base of lobe ; remainder of patch usually pale or very pale orange-brown but sometimes largely dark brown. A very short seta arises above spiracle on, but near edge of, glabrous area of disc. Each lateral lobe with a narrow black longitudinal stripe on basal half, stripe occasionally incomplete or absent ; with two short setae close together immediately beyond apical end of stripe. Each ventral lobe at base with a row of three small black spots in a very narrow, brown or pale brown, transverse stripe ; outer margin unpigmented ; inner margin usually pale or very pale brown towards tip ; tip with a small dark brown patch and four very short setae, as in fig. 60. Spiracles slightly oval ; plate brown or dark brown ; stigmatic scar black. *Anal field* : marginal band brown or dark brown ; anal papillae represented by four rounded lobes anterior to anus and separated from it by a narrow pigmented band similar to marginal band (fig. 60).

Distribution.—Recorded from S.W. Ireland (Killarney), Inverness (Abernethy and Aviemore), Perthshire (Rannoch), and Merioneth (Dolgelly). Rare.

Comparative notes.—The spiracular disc and the anal field are similar to those of the larva of *T. scripta*, but in the latter the pigmented patch on each dorsal lobe is larger and the patch at the tip of each ventral lobe is both larger and darker than in *T. rubripes* (cf. figs. 60 and 61). The larva is unlikely to be confused with that of any of the other species described here.

The description is based on five larvae kindly loaned me by Dr. F. I. van Emden.

Habits.—The larvae live in soil in coniferous woods.

Tipula livida v. d. Wulp. (Figs. 32–36, 62–64).

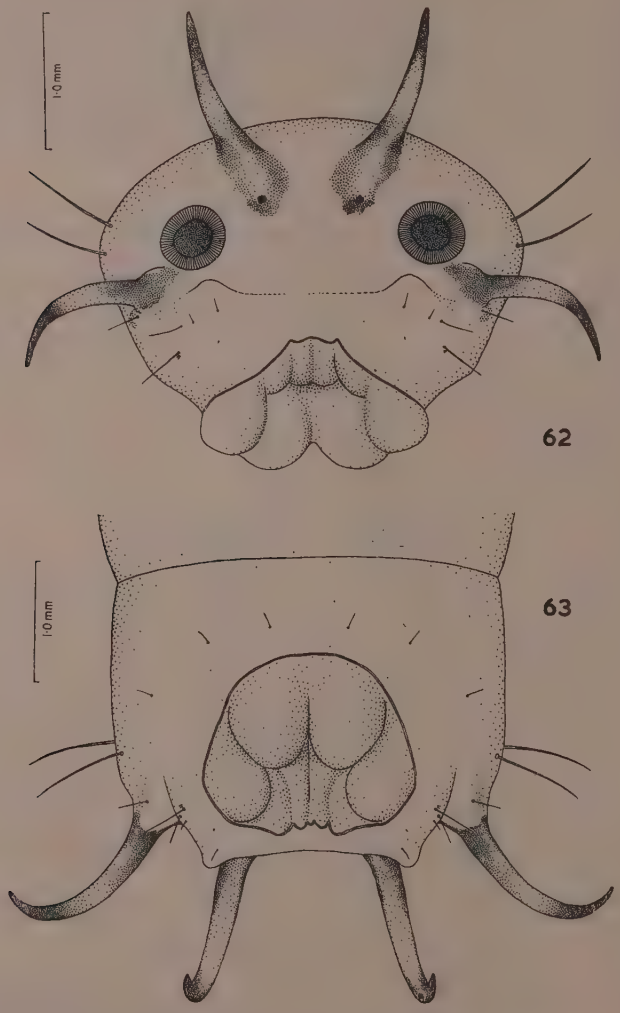
Last instar larva.—Length, 30 mm.; breadth, 4 mm. Cuticle unpigmented ; clothed with pale brown, very short, adpressed, silky pubescence that is longer and denser on first three segments. *Spiracular disc* (fig. 62) : dorsal and lateral lobes of disc are heavily sclerotised, long, slender, curved horns, black at tip and base and brown between. Each dorsal lobe with sclerotisation extending ventrally on to disc between spiracles as a large dark brown patch ; with a smaller patch at base of each lateral lobe below spiracle. Dorsal side of last abdominal segment with two moderately large brown patches, each joined to base of dorsal lobe by a pale brown stripe (fig. 64). Ventral lobes fleshy, about half as long as breadth at base ; each with a small, brown or pale brown, crescentic or angular transverse patch just before tip ; tip with six very short setae, as in fig. 64. Marginal hair fringe absent. Spiracles circular or slightly oval, greatest diameter 0·48–0·52 mm.; plate dark brown ; stigmatic scar black. *Anal field* : marginal band pale brown or brown ; anal papillae represented by four rounded lobes anterior to anus (fig. 63).

Third instar larva.—Length, 8 mm.; breadth, 1 mm.[11] ; greatest diameter of spiracle around 0·25 mm. Very similar to last instar but with dorsal and lateral lobes of disc relatively longer and spiracles more oval with plate relatively broader.

Distribution.—Wilts. (Ford, near Castle Coombe) and Somerset (Leigh Woods, near Bristol). Rare.

[11] Description based on a single larva which was probably not fully grown.

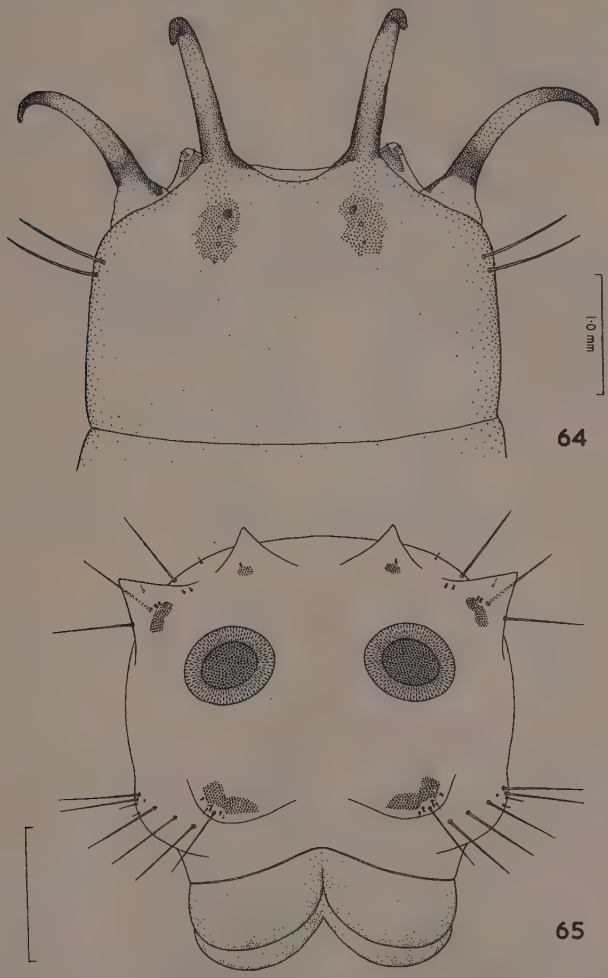
Comparative notes.—The larva is not likely to be confused with that of any of the other species described here because in no other species are the dorsal and lateral lobes of the disc entirely sclerotised and hook-like. In the other four species of the subgenus *Lunatipula* that are described here (*T. lunata*, *T. selene*, *T. cava* and *T. brevispina*) the basal half of each dorsal lobe is unsclerotised anteriorly and laterally, and the lateral lobes are unsclerotised apart from a longitudinal stripe on the posterior side of each. I have already noted (Chiswell,



FIGS. 62–63.—*Tipula livida* v. d. Wulp, last abdominal segment. (62) Posterior view. (63) Ventral view.

1955) that the larva described by Beling (1878) as *T. selene* is certainly not that species but is very probably *T. livida*.

Habits.—The larvae live in leaf mould and moist soil in woods.



Figs. 64–65.—(64) *Tipula livida* v. d. Wulp, dorsal view of last abdominal segment. (65) *T. flavolineata* Meigen, posterior view of last abdominal segment.

Tipula lunata L. (Figs. 66, 71).

Last instar larva.—Length, 27 mm.; breadth, 4 mm. Cuticle unpigmented ; clothed with dense, very short pubescence that is slightly longer on dorsal side of last two or three segments, especially the last ; pubescence brown and transversely banded dorsally and ventrally, pale brown and uniform on pleura. *Spiracular disc* (fig. 66) : dorsal and lateral

lobes conical with pointed tips, dorsal lobes usually clearly shorter than lateral lobes; dorsal lobes from one to one-and-a-half times as long as breadth at base, lateral lobes from one-and-a-half times to twice as long as breadth at base. Ventral lobes about three-fifths as long as breadth at base, with moderately narrow, upcurved tips. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with extreme tip entirely sclerotised and curved anteriorly (fig. 71); posterior surface with a very broad, heavily sclerotised black stripe extending on to disc between spiracles (stripes frequently joined at base, as in fig. 66, or narrowly separated); stripe with a very short, inconspicuous seta near its outer edge, usually at level of dorsal margin of glabrous area of disc (dotted line, fig. 66), and with a minute, circular, unpigmented, probably sensory, plate at its middle near base of lobe. Each lateral lobe with a moderately broad, black, median longitudinal stripe, and with two very short setae close together in dorsal edge of stripe near base of lobe; stripe sometimes slightly longer or slightly narrower than in fig. 66. Each ventral lobe with upper surface almost entirely pigmented, largely dark brown with two black spots at base, frequently paler brown at middle; five short setae near tip of lobe, as in fig. 66. Width of unpigmented part of disc between patches on ventral lobes always less than greatest diameter of spiracle, usually about half this diameter. Spiracles circular or slightly oval, greatest diameter 0·5–0·6 mm.; plate brown; stigmatic scar usually black at edges and dark reddish-brown at middle, sometimes entirely black. *Anal field*: marginal band pale brown or brown; anal papillae represented by four rounded lobes anterior to anus.

Third instar larva.—Length, 20 mm.; breadth, 2·5 mm. Cuticle with pubescence as in last instar but paler brown. *Spiracular disc*: differs from that of last instar as follows: (1) dorsal lobes relatively shorter, rarely longer than breadth at base, tip not obviously curved, and longitudinal stripes always clearly separated at base; (2) ventral lobes relatively shorter with sclerotised patches slightly paler and separated by a distance about equal to greatest diameter of spiracle. Spiracles usually slightly oval, greatest diameter 0·26–0·32 mm. *Anal field*: as in last instar.

Distribution.—Generally distributed. Common.

Comparative notes.—The presence of the broad, dark brown patch on each ventral lobe of the disc is usually sufficient to distinguish the larva from those of *T. scripta*, *T. selene*, *T. cava* and *T. brevispina*. The middle of the patch is sometimes pale and may resemble the corresponding patch in *T. brevispina*, but the distance between the patches is always clearly less than the greatest diameter of the spiracle, whereas in *T. brevispina* and the other three species it is never less than this diameter. The black longitudinal stripes on the dorsal and lateral lobes are usually broader than in the other four species.

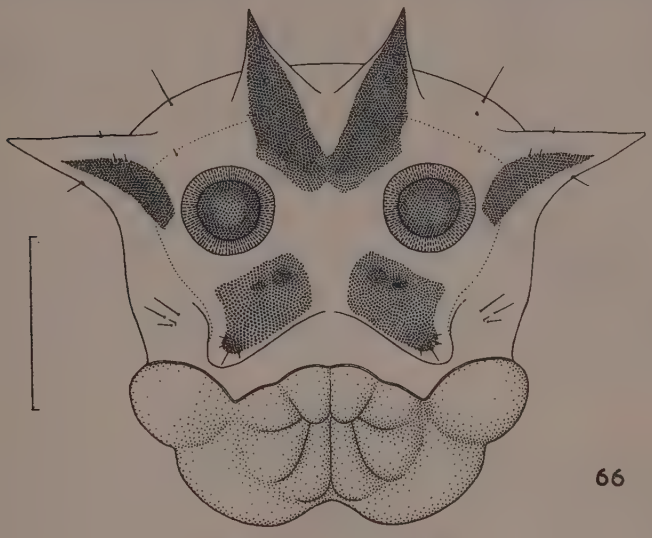
The larvae of this species and of *T. scripta*, *T. selene*, *T. cava* and *T. brevispina* all possess the combination of characters described in the first part of couplet 13 of the key. With the exception of *T. scripta*, they all belong to the subgenus *Lunatipula*. Edwards (1931) placed three other British species in this subgenus, namely, *T. fascipennis*, *T. helvola* and *T. peliostigma*, and it seems likely that their larvae will be found to possess a similar combination of characters.

Habits.—The larvae live in moist soil and leaf mould, usually in woods or under hedges.

Tipula selene Meigen. (Fig. 67).

Last instar larva.—Length, 23 mm.; breadth, 3 mm. Cuticle unpigmented; clothed with dense, very short pubescence that is slightly longer on first three segments and on dorsal side of last segment; pubescence moderately pale brown and transversely banded dorsally and ventrally, pale brown and uniform on pleura. *Spiracular disc* (fig. 67): dorsal and lateral

lobes conical, from one-and-a-half times to twice as long as breadth at base. Each dorsal lobe more strongly tapered in basal half than in apical half, apical half very slender with pointed and anteriorly curved tip. Each lateral lobe uniformly tapered with pointed or narrowly rounded tip. Each ventral lobe about as long as breadth at base, with narrow upcurved tip. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with apical half entirely sclerotised ; posterior surface with a broad, heavily sclerotised black stripe extending on to



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Figs. 66–67.—(66) Posterior view of last abdominal segment of *Tipula lunata* L. (67) Same of *T. selene* Meigen.

disc between spiracles, as in fig. 67 ; stripe with a very short, inconspicuous seta near its outer edge, usually just above dorsal margin of glabrous area of disc, and with a minute, circular, unpigmented, probably sensory, plate at or near middle of lobe. Stripes on dorsal lobes always clearly separated at base. Each lateral lobe with a moderately broad black longitudinal stripe that extends almost to tip of lobe, with two very short setae fairly close together in dorsal edge of stripe at or near middle of lobe (fig. 67) ; stripe sometimes broader at base than in fig. 67 and almost reaching spiracle. Each ventral lobe with upper surface almost entirely pigmented, pigmented patch with two black spots at base, otherwise either entirely brown to dark brown (fig. 67) or with a paler area just posterior to (i.e. below) basal spots. Width of unpigmented part of disc between patches on ventral lobes always clearly greater than greatest diameter of spiracle. Spiracles almost circular ; plate brown or dark brown, stigmatic scar usually entirely black, sometimes dark reddish-brown at middle. *Anal field* : marginal band brown or pale brown ; anal papillae represented by four rounded lobes anterior to anus.

Distribution.—Carnarvon southwards to Hants. (New Forest). Uncommon.

Comparative notes.—The larva is only liable to be confused with that of *T. lunata* but the ventral lobes are narrower and slightly longer than in the latter, and the distance between the narrow pigmented patches on them is nearly one-and-a-half times the greatest diameter of the spiracle, whereas in *T. lunata* this distance is usually only half the greatest diameter of the spiracle.

Habits.—A larva was found in debris inside the hollow trunk of a willow at the side of a river.

Tipula cava Riedel. (Fig. 68).

Last instar larva.—Length, 20 mm.; breadth, 3 mm.[12]. Cuticle unpigmented ; clothed with pale brown, dense, very short pubescence that is slightly longer on first three segments and on dorsal side of last segment. *Spiracular disc* (fig. 68) : dorsal lobes conical with slender, pointed, anteriorly curved tips ; slightly longer than breadth at base. Lateral lobes conical with narrowly rounded tips ; slightly longer than dorsal lobes. Ventral lobes about half as long as breadth at base, with rounded upcurved tips. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with extreme tip entirely sclerotised ; posterior surface with a broad black longitudinal stripe extending on to disc between spiracles, as in fig. 68 ; stripe with a very short seta immediately beyond its outer edge near base of lobe, and with a minute, circular, unpigmented, probably sensory, plate near middle of lobe. Stripes on dorsal lobes widely separated at base. Each lateral lobe with a moderately narrow longitudinal stripe as in fig. 68, stripe dark brown or black except for apical third, which is very pale brown and inconspicuous. Each ventral lobe with pigmented patches as in fig. 68, transversely elongate patch at base dark brown with two black spots on broader inner part ; outer margin unpigmented ; inner margin with a pale brown stripe continuous at tip with a moderately large dark brown patch ; five very short setae arise at tip, as in fig. 68. Width of unpigmented part of disc between patches on ventral lobes about equal to greatest diameter of spiracle. Spiracles slightly oval ; plate rather dark brown ; stigmatic scar black. *Anal field* : marginal band dark brown ; anal papillae represented by four rounded lobes anterior to anus.

Distribution.—Generally distributed. Common in woods.

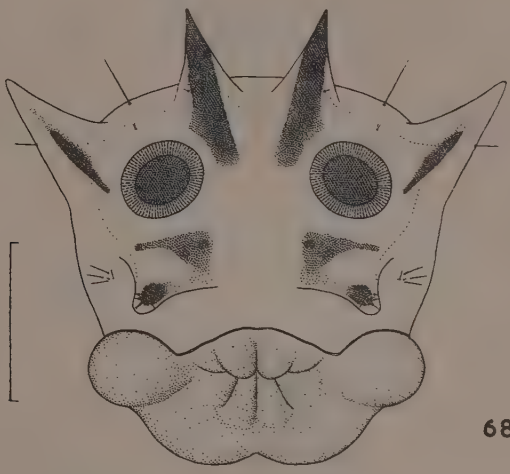
Comparative notes.—The larva is only liable to be confused with that of *T. brevispina*, but can be distinguished from it by the characters listed in the key. In addition it may be noted that the dorsal lobes of the spiracular disc

[12] The two larvae examined were probably not fully grown, and it seems likely that mature larvae attain a length of about 25 mm. and a breadth of about 4 mm.

are shorter than those of *T. brevispina* and are only slightly curved at the tip (i.e. as in fig. 71), whereas in the latter species they are distinctly curved (fig. 70).

The description is based on two last instar larvae kindly loaned me by Dr. F. I. van Emden.

Habits.—Coe (1941) bred this species from dried cow dung. The adults are usually found in woods, and the typical larval habitat is likely to be soil and leaf mould or possibly decaying wood.



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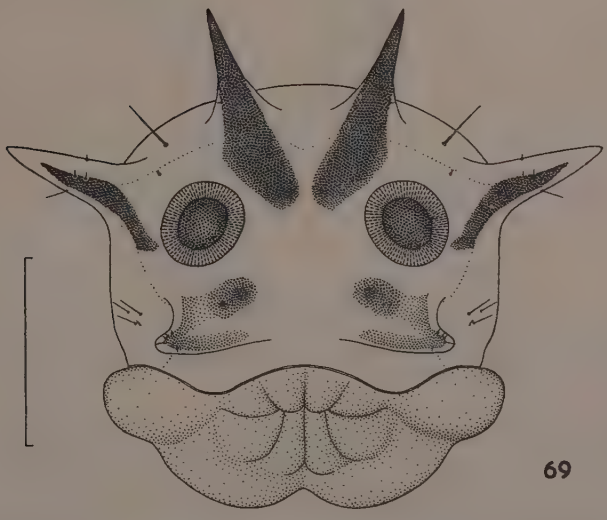

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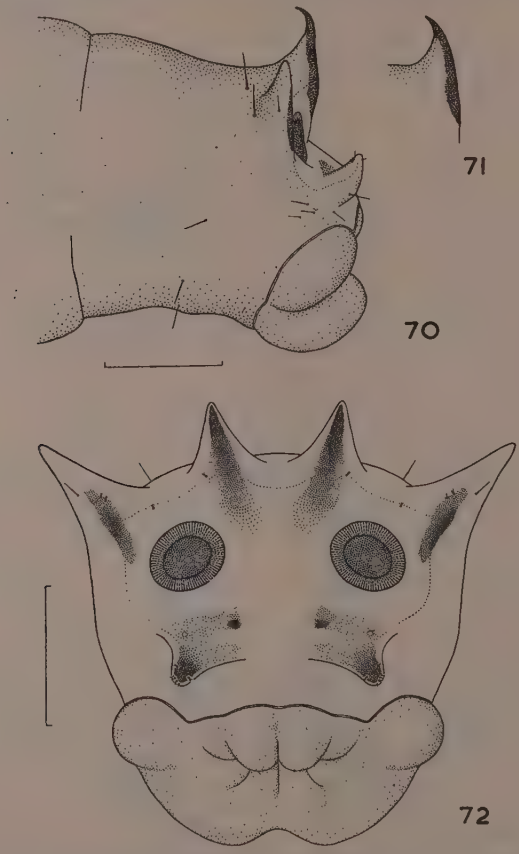
FIGS. 68–69.—(68) Posterior view of last abdominal segment of *Tipula cava* Riedel. (69) Same of *T. brevispina* Pierre.

Tipula brevispina Pierre. (Figs. 69–70).

Last instar larva.—Length, 25 mm.; breadth, 3 mm. Cuticle unpigmented; clothed with dense, very short pubescence that is slightly longer on first three segments and on dorsal side of last segment; pubescence pale brown and transversely banded dorsally and ventrally but very pale brown and uniform on pleura. *Spiracular disc* (fig. 69): dorsal and lateral lobes conical, nearly twice as long as breadth at base. Each dorsal lobe more strongly



Figs. 70–72.—(70) *Tipula brevispina* Pierre, side view of last abdominal segment. (71) *T. lunata* L., side view of dorsal lobe of spiracular disc. (72) *T. vernalis* Meigen, posterior view of last abdominal segment.

tapered in basal half or two-thirds than in apical part; apical part very slender with pointed, anteriorly curved tip (fig. 70). Each lateral lobe uniformly tapered with pointed or narrowly rounded tip. Each ventral lobe about half as long as breadth at base, with moderately narrow upcurved tip. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with apical third entirely sclerotised; posterior surface with a broad heavily sclerotised black stripe extending on to disc between spiracles, as in fig. 69; stripe with a very short, incon-

spicuous seta near its outer edge at about middle of its length, and with a minute, circular, unpigmented, probably sensory, plate at middle just above level of seta. Stripes on dorsal lobes always clearly separated at base. Each lateral lobe with a moderately broad, black, longitudinal stripe ; with two very short setae fairly close together in dorsal edge of stripe at or near middle of lobe. Each ventral lobe at base with two black spots in a moderately dark brown patch, with paler pigmentation between patch and stripe on outer margin ; inner and outer margins with brown or pale brown stripes that join at tip ; tip with five very short setae, as in fig. 69. Width of unpigmented part of disc between patches on ventral lobes never less and usually slightly greater than greatest diameter of spiracle. Spiracles slightly oval, greatest diameter 0·48–0·55 mm.; plate brown ; stigmatic scar usually black peripherally and dark reddish-brown at middle, sometimes entirely black. *Anal field*: marginal band brown or pale brown ; anal papillae represented by four rounded lobes anterior to anus.

Third instar larva.—Length, 19 mm.; breadth, 2 mm. Cuticle with pubescence slightly paler than in last instar, otherwise similar. *Spiracular disc* : dorsal and lateral lobes slightly shorter than in last instar, disc otherwise similar ; greatest diameter of spiracle 0·25–0·27 mm. *Anal field* : as in last instar.

Distribution.—Previous records from WESTMORLAND, N. LANCS., and GLOUCESTERSHIRE. Present records from SOMERSET (Leigh Woods, near Bristol) and GLOUCESTERSHIRE (Blaise Castle, near Bristol). Probably not rare ; in woods.

Comparative notes.—The larva can be distinguished from that of *T. cava* by the characters given in the key. It resembles the larva of *T. selene* in that the dorsal and lateral lobes of the disc are moderately long and slender, but differs from it in the shape of the ventral lobes and of the pigmented patches on them (cf. figs. 67 and 69).

Habits.—The larvae live in moist woodland soil or under bark or in debris on decaying logs and stumps.

Tipula vernalis Meigen. (Fig. 72).

Last instar larva.—Length, 24 mm.; breadth, 4 mm. Cuticle unpigmented ; clothed with pale brown, dense, very short pubescence that is slightly longer on dorsal side, especially of last one or two segments, than elsewhere. *Spiracular disc* (fig. 72) : dorsal and lateral lobes conical with narrowly rounded tips ; dorsal lobes about as long as breadth at base, lateral lobes about half as long again as dorsal lobes. Ventral lobes about half as long as breadth at base ; tips rounded. Glabrous area of disc extending to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Each dorsal lobe with a tapered longitudinal stripe extending from tip on to disc between spiracles, as in fig. 72 ; stripe black on apical half of lobe, progressively paler below and pale brown at basal end ; a very short bifid seta arises immediately beyond outer edge of stripe at or near margin of glabrous area of disc. Each lateral lobe with a moderately broad longitudinal stripe on basal half, stripe black at middle, otherwise largely dark brown ; two very short unbranched or bifid setae arise fairly close together in dorsal edge of stripe near its apical end. A very short bifid seta arises above outer edge of spiracle near margin of glabrous area of disc. Each ventral lobe pigmented, as in fig. 72 ; basal spot black, apical part of lobe dark brown or black, pigmentation otherwise pale brown ; tip with six very short setae, three unbranched and three bifid, as in fig. 72. Width of unpigmented part of disc between patches on ventral lobes about equal to least diameter of spiracle. Spiracles slightly oval; plate brown, stigmatic scar reddish-brown to black. *Anal field* : marginal band dark brown ; anal papillae represented by four rounded lobes anterior to anus, lateral lobes smaller than ventral lobes.

Earlier stages.—De Jong (1925) has described the egg and the first instar larva.

Distribution.—Generally distributed. Common.

Comparative notes.—The spiracular disc is generally similar to that of larvae of the four preceding species, but the tips of the dorsal lobes are not sharply pointed nor entirely sclerotised, and the stripes on the dorsal and lateral lobes are not entirely black.

The description is based on a single larva kindly loaned me by Dr. F. I. van Emden.

Habits.—The larvae usually live in grassland soil. According to Balachowsky and Mesnil (1935), they may sometimes cause damage to cultivated grasses and legumes.

Tipula maxima Poda. (Figs. 73, 75–76).

Last instar larva.—Length, 50 mm.; breadth, 6 mm. Cuticle unpigmented; clothed with brown or greyish brown, dense, very short pubescence that is slightly longer on dorsal side of last two segments; small tufts of long and usually darker pubescence at or near bases of nearly all setae. *Spiracular disc* (fig. 73): all lobes tapered, about as long as breadth at base, posterior surfaces flattened. Glabrous area of disc extending to tips of ventral lobes and almost to tips of dorsal and lateral lobes; marginal hair fringe present, hairs moderately long. Each dorsal lobe with a very short seta at tip just inside hair fringe, and each margin with a broad brown stripe; stripe on outer margin shorter and slightly paler and with a minute, circular, unpigmented, probably sensory, plate at or near middle. Each lateral lobe with four short setae arising just inside hair fringe, two very close together at tip and two more separated at extreme base of dorsal margin; dorsal margin unpigmented; ventral margin with a moderately broad brown stripe that usually has a darker central streak and a sub-apical spot, as in fig. 73. Each ventral lobe at base with a wedge-shaped transverse stripe, as in fig. 73, broader inner end of stripe brown with a large elongate or oval black patch at centre, narrower outer end paler brown with a small black spot; outer margin of lobe unpigmented; inner margin with a moderately broad brown stripe not reaching patch at tip; patch at tip brown with black central longitudinal stripe and with an unpigmented area from which arises a long slender seta; four [13] shorter setae arise between dark patch and hair fringe, as in fig. 73. Spiracles slightly oval, greatest diameter 0·65–0·75 mm.; plate brown, stigmatic scar black. *Anal field*: marginal band dark brown or black. Eight anal papillae anterior to anus (fig. 75); two lateral pairs three or four times as long as breadth at base and usually held pointing upwards close to body, anterior pair slightly shorter than posterior pair; two ventral pairs scarcely longer than breadth at base, anterior pair smaller than posterior pair.

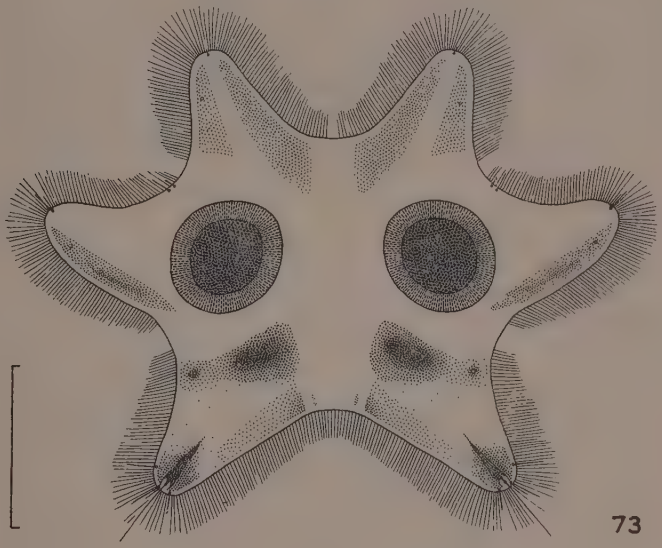
Third instar larva.—Length, 30 mm.; breadth, 3·5 mm. Cuticle with pubescence paler than in last instar, otherwise similar. *Spiracular disc*: all lobes relatively shorter than in last instar and with brown patches darker and more extensive as follows: (1) each dorsal lobe with marginal stripes often broader, sometimes almost meeting in mid-line; (2) each lateral lobe usually with a narrow brown stripe along dorsal margin as well as a broader stripe along ventral margin; (3) each ventral lobe pigmented as in last instar but often with a brown stripe along outer margin as well as inner, both stripes reaching dark patch at tip. Spiracles as in last instar but smaller relative to size of spiracular disc, greatest diameter 0·35–0·37 mm. *Anal field*: as in last instar but with anal papillae relatively slightly longer.

Distribution.—Generally distributed. Frequent, mainly in woods.

Comparative notes.—The larva of this species and that of *T. fulvipennis* are very similar, and can be distinguished from the larvae of all the other Tipulinae

[13] Of these four setae, the shorter of the middle two, which arise very close together, is often very difficult to see even in slide mounts of the spiracular disc. It is omitted by Brown (1910, figs. 5 and 5*a*), who has labelled the ventral lobes as dorsal lobes.

described here by the presence of eight anal papillae, of which four are very long and slender and four are very short. The larvae of *T. rufina*, *T. marmorata* and *T. cheethami* also have eight anal papillae, but these are all of more or less equal length and quite short (figs. 97, 98).



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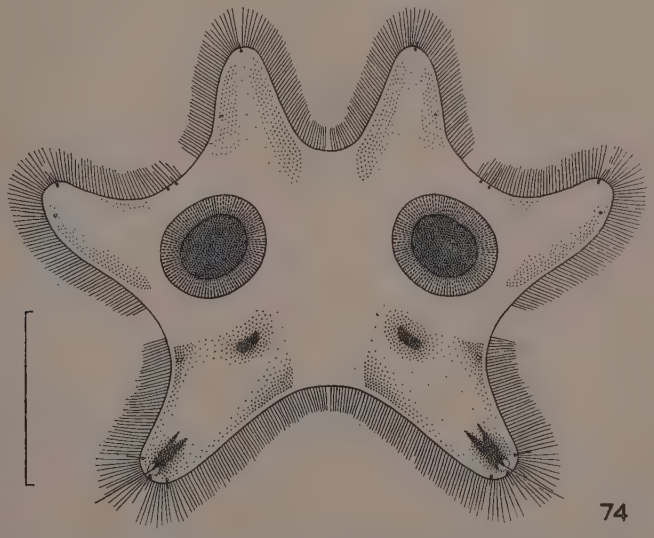

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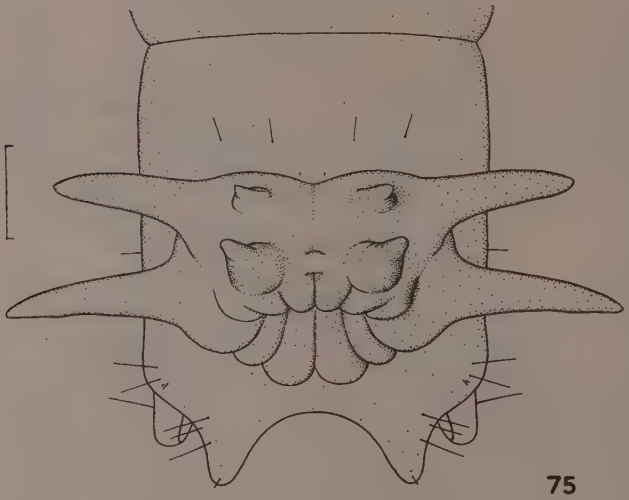
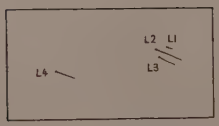
FIGS. 73–74.—(73) Spiracular disc of *Tipula maxima* Poda.
(74) Same of *T. fulvipennis* Degeer.

Habits.—The larvae live in leaf mould or in moist to saturated soil, usually at the edges of ponds and streams. I have occasionally found them submerged under stones in the bed of a small stream a few inches deep.

Tipula fulvipennis Degeer. (Figs. 74, 77).

Last instar larva.—Length, 40 mm.; breadth, 4 mm. Cuticle unpigmented; clothed with brown or greyish-brown, dense, very short pubescence that is slightly longer on dorsal side of last two segments; small tufts of long and usually darker pubescence at or near bases of nearly all setae. *Spiracular disc* (fig. 74): all lobes tapered, about as long as breadth





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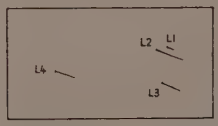

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FIGS. 75–77.—(75) *Tipula maxima* Poda, ventral view of last abdominal segment. (76) Map of setae on left pleuron of each of abdominal segments 2–7 of *T. maxima* Poda. (77) Same of *T. fulvipennis* Degeer.

at base, posterior surfaces flattened. Glabrous area of disc extending to tips of ventral lobes and almost to tips of dorsal and lateral lobes; marginal hair fringe present, hairs fairly long. Each dorsal lobe with apical seta and marginal stripes as in *T. maxima* but stripes pale brown with inner edge of each indistinct. Each lateral lobe with four short setae and stripe along ventral margin as in *T. maxima*, but usually also with a very pale brown stripe on basal half of dorsal margin, as in fig. 74. Each ventral lobe at base with a small elongate black patch in a pale or very pale brown area that does not usually extend laterally to base of outer marginal stripe (fig. 74); inner and outer margins of lobe each with a narrow

pale or very pale brown stripe, broader and darker at base, narrow and often very pale beyond but usually reaching tip of lobe ; tip brown with a black median longitudinal stripe usually bifurcate at basal end (fig. 74) and with an unpigmented area from which arises a long slender seta ; four shorter setae, the middle two very close together, arise at tip of lobe between dark patch and hair fringe. Spiracles slightly oval, greatest diameter 0·60–0·66 mm.; plate brown ; stigmatic scar dark brown or black. *Anal field :* as in *T. maxima.*

Distribution.—Generally distributed. Frequent, mainly in woods.

Comparative notes.—The larva is very similar to that of *T. maxima* but can be distinguished from it by the characters given in the key. The full-grown larva is slightly smaller than that of *T. maxima* and the lobes of the spiracular disc are slightly narrower than in the latter species.

Habits.—As for *T. maxima.*

Tipula vittata Meigen. (Figs. 78–79).

Last instar larva.—Length, 40 mm. ; breadth, 4 mm. Cuticle unpigmented ; clothed with greyish-brown, dense, very short pubescence that is slightly longer on dorsal side of last segment ; small tufts of longer and usually darker pubescence at or near bases of almost all setae. *Spiracular disc* (fig. 78) : all lobes tapered, about as long as breadth at base, with posterior surfaces flattened. Tip of each dorsal and lateral lobe with a small dense tuft of short dark hairs ; anterior side of each lateral lobe with a narrow longitudinal band of similar hairs. Glabrous area of disc extending to tips of ventral lobes and almost to tips of dorsal and lateral lobes ; marginal hair fringe present, hairs short. Each dorsal lobe with a very short seta at tip just inside hair fringe, and with a broad brown or dark brown stripe on each margin ; stripe on outer margin shorter and sometimes slightly paler than that on inner margin, stripes frequently joined at tip of lobe, as in fig. 78. Each lateral lobe with four short setae arising just inside hair fringe, two very close together at tip and two fairly close together at extreme base of dorsal margin ; dorsal margin at base with a small pale or very pale brown patch ; ventral margin with a broad brown stripe that has a small blackish spot near its tip. Each ventral lobe at base with a conspicuous, broad, dark brown or black, Λ-shaped transverse stripe with a paler extension along basal half of inner margin of lobe ; outer margin unpigmented ; tip with a broad dark brown to black patch with an unpigmented area from which arises a long slender seta ; four short setae, the middle two very close together, arise between dark apical patch and hair fringe, as in fig. 78. Spiracles slightly oval, greatest diameter 0·58–0·68 mm.; plate dark brown, stigmatic scar black. *Anal field* : marginal band dark brown or black. Four stout and conical anal papillae anterior to anus (fig. 79) ; papillae scarcely longer than breadth at base, ventral pair smaller than lateral pair.

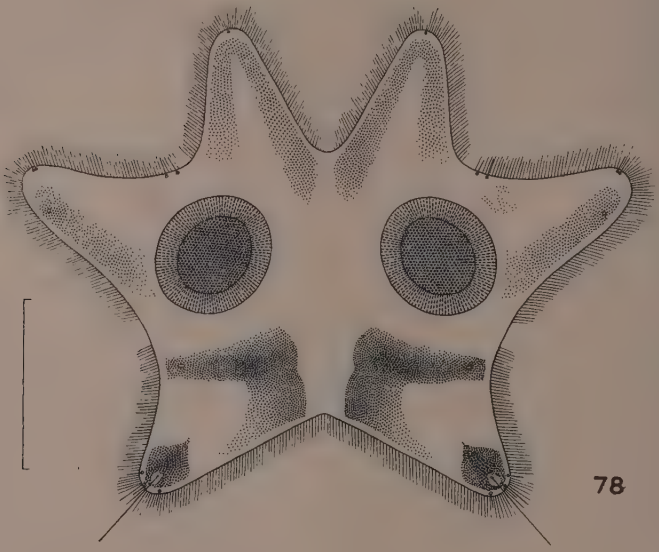
Third instar larva.—Length, 25 mm.; breadth, 2·5 mm. Cuticle with pubescence as in last instar. *Spiracular disc* : all lobes relatively slightly shorter than in last instar, with brown stripes more extensive as follows : (1) each lateral lobe with a broad pale brown or brown stripe on dorsal margin as well as on ventral margin, stripes joined at tip of lobe ; and (2) each ventral lobe with pigmented areas as in last instar but with stripe on inner margin reaching dark patch at tip. Spiracles more oval than in last instar, greatest diameter 0·30–0·34 mm.; plate pale brown or brown, stigmatic scar black. *Anal field* : as in last instar.

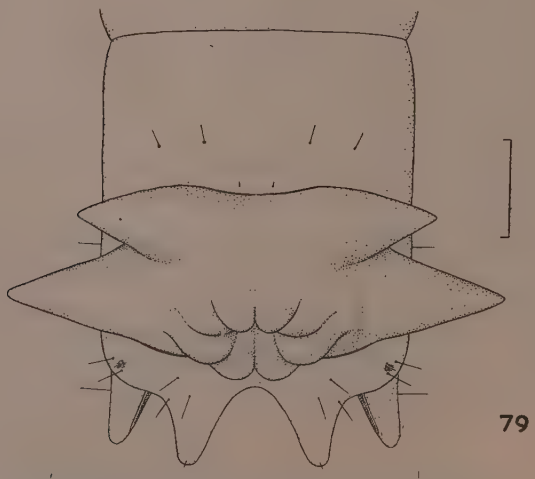
Distribution.—Generally distributed. Frequent in damp woods.

Comparative notes.—The larva can be distinguished from that of *T. luna* by the characters given in the key. It resembles the larvae of *T. maxima* and

T. fulvipennis in that the lobes of the spiracular disc are similar in size and shape and have a generally similar pattern of brown stripes and patches, but *T. vittata* has only four anal papillae, whereas *T. maxima* and *T. fulvipennis* have eight.

Habits.—The larvae live in leaf mould or in moist to saturated soil, usually at the edges of ponds and streams.

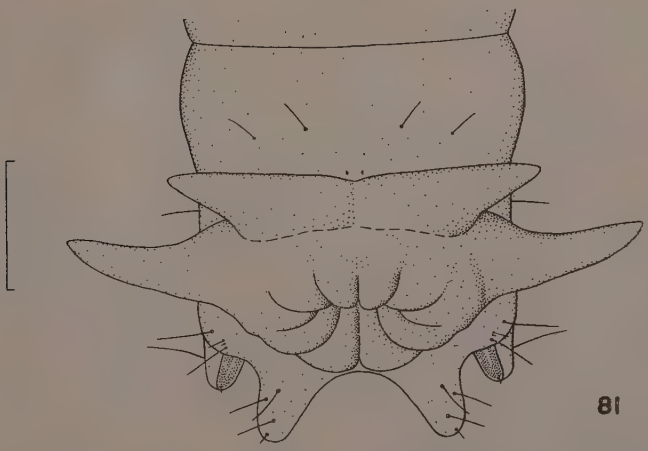




Figs. 78–79.—*Tipula vittata* Meigen. (78) Spiracular disc. (79) Ventral view of last abdominal segment.

Tipula luna Westhoff. (Figs. 80–81).

Last instar larva.—Length, 30 mm.; breadth, 3·5 mm. Cuticle unpigmented; clothed with yellowish- or greyish-brown, moderately dense, short pubescence that is slightly longer on dorsal side of last two segments; small tufts of longer and usually darker pubescence at or near bases of nearly all setae. *Spiracular disc* (fig. 80): all lobes tapered, slightly longer than breadth at base, with posterior surfaces flattened. Tip of each dorsal and lateral lobe with a small dense tuft of short dark hairs; anterior side of each lateral lobe usually



Figs. 80–81.—*Tipula luna* Westhoff. (80) Spiracular disc. (81) Ventral view of last abdominal segment.

with a narrow longitudinal band of short dark hairs. Glabrous area of disc extending to tips of ventral lobes and almost to tips of dorsal and lateral lobes: marginal hair fringe present, hairs moderately long and deeply pigmented at extreme base. Each dorsal lobe with a very short seta at tip just inside hair fringe, and with very broad pale orange-brown marginal stripes almost meeting in mid-line: outer stripe with a minute, circular, unpigmented, probably sensory, plate near middle. Each lateral lobe with four short setae arising just inside hair fringe, two very close together at tip and two moderately close together at extreme base of dorsal margin: dorsal and ventral margins each with a broad pale brown stripe with inner edge indistinct: dorsal stripe often very pale except at base and tip, and sometimes incomplete: ventral stripe with a small dark spot near tip. Each ventral lobe extensively orange-brown across base, on margins, and at tip, as in fig. 80: base with a short black transverse stripe: tip with a short black longitudinal stripe frequently bifurcate at basal end and with an unpigmented area from which arises a long slender seta: four other setae, the middle two very close together, arise at tip of lobe just inside hair fringe (fig. 80). Spiracles slightly oval: plate brown, stigmatic scar black. *Anal field*: marginal band dark brown or black. Four conical anal papillae anterior to anus (fig. 81): ventral pair slightly longer than breadth at base, lateral pair about twice as long as breadth at base.

Distribution.—Generally distributed. Frequent.

Comparative notes.—The larva is generally similar to that of *T. vittata* but the pigmented areas on the spiracular disc are paler and more extensive than in the latter and the anal papillae are more slender. The two species can be distinguished by these differences, which are listed in the key. In addition, the dark and rather conspicuous basal pigmentation of the hairs of the marginal fringe of *T. lunata* is lacking from the hairs of *T. vittata*, and the general body pubescence of the latter is much shorter and denser. *T. lunata* larvae are yellowish-brown, whereas *T. vittata* larvae are greyish-brown.

Habits.—The larvae usually live among plant roots in wet or saturated soil in marshy fields or at the edges of ponds and streams.

Tipula irrorata Macquart. (Figs. 82–84).

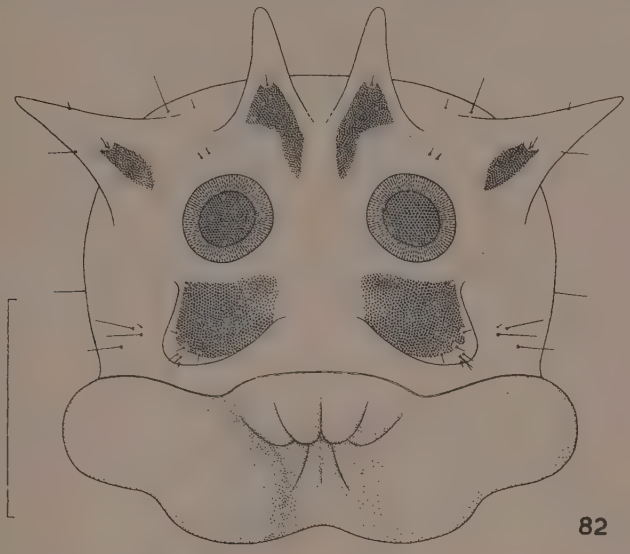
Last instar larva.—Length, 24 mm.: breadth, 2·5 mm. Cuticle unpigmented: clothed with greyish-brown, dense, very short pubescence that is transversely banded except on pleura, slightly longer on dorsal side, especially of second, third and last segments, and slightly less dense on pleura. *Spiracular disc* (fig. 82): dorsal and lateral lobes conical with pointed or narrowly rounded tips, dorsal lobes about two-thirds as long and thick as lateral lobes; ventral lobes small, about two-thirds as long as breadth at base, with broadly rounded tips: rather widely separated at base. Glabrous area of disc extending almost to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Disc with setae and conspicuous dark brown or black patches, as in fig. 82. Precise shape of patches variable: patch on each dorsal lobe with ventral extension sometimes narrower than in fig. 82; patch on each lateral lobe sometimes broad and truncate near spiracle (not pointed as in fig. 82), always wider than plate of spiracle. Spiracles slightly oval, greatest diameter 0·38–0·43 mm.: plate pale brown or brown: stigmatic scar entirely black, or dark reddish-brown at middle. *Anal field*: marginal band pale brown or brown. Anal papillae reduced to four rounded lobes anterior to anus (figs. 82 and 83).

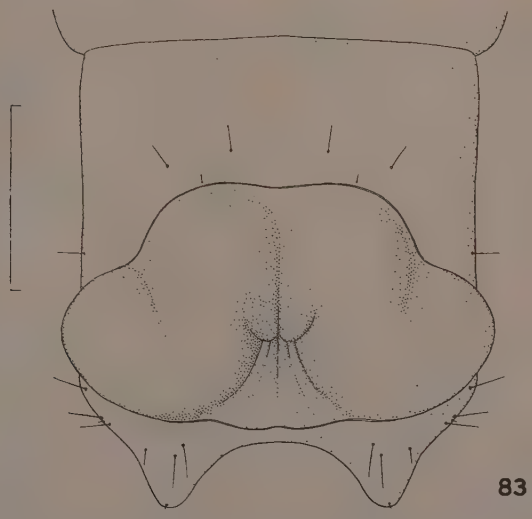
Third instar larva.—Length, 15 mm.: breadth, 1·5 mm. Apart from size, entirely similar to last instar. Greatest diameter of spiracle 0·20–0·23 mm.

Distribution.—Generally distributed. Frequent.

Comparative notes.—The larva is very similar to those of *T. hortulana* Meig. and *T. variipennis* Meig. but can be distinguished from them by the greater

width of the stripe on each lateral lobe of the spiracular disc, as described in the key. The larva of *T. irrorata* is greyish whereas that of *T. hortulana* is rather reddish-brown. In *T. irrorata* the upper surface of each ventral lobe of the spiracular disc is entirely dark brown, whereas in *T. variipennis* it is only partly brown. There are also differences in habitat which make identification easier :

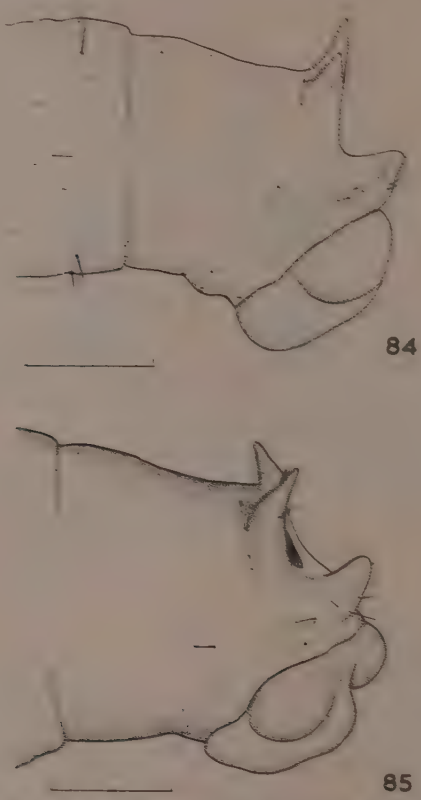




FIGS. 82–83.—*Tipula irrorata* Macquart. (82) Spiracular disc. (83) Ventral view of last abdominal segment.

the larvae of *T. irrorata* live in or on decaying wood or in moss, whereas those of *T. hortulana* and *T. variipennis* live in soil.

Habitat.—The larvae live under bark or in moss and debris on decaying logs and stumps, usually in woods.

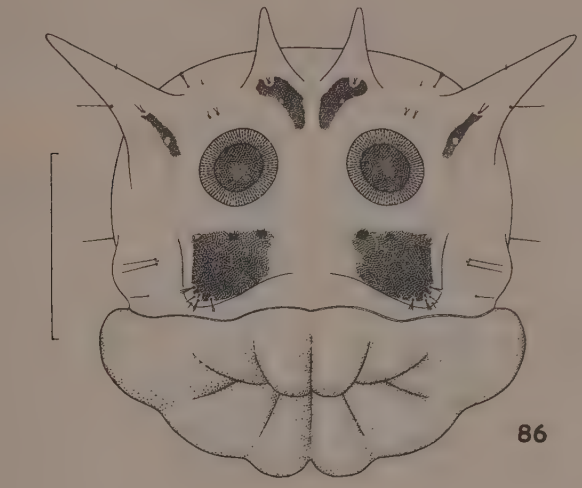


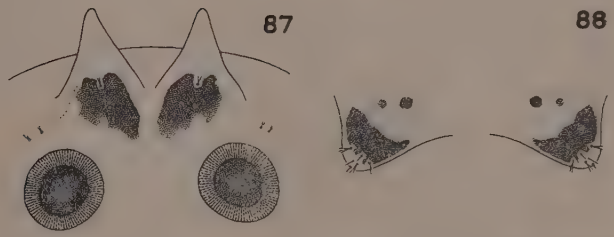
FIGS. 84–85.—84. Side view of last abdominal segment of *Tipula irrorata* Macquart. (85) Same of *T. hortulana* Meigen.

Tipula hortulana Meigen. (Figs. 85–87).

Last instar larva.—Length, 28 mm.; breadth, 3 mm. Cuticle unpigmented; clothed with rather reddish-brown, dense, very short pubescence that is transversely banded except on pleura; pubescence slightly longer on dorsal side, especially of second, third, and last two segments, and shortest on pleura. *Spiracular disc* (fig. 86): dorsal and lateral lobes conical with pointed or narrowly rounded tips, dorsal lobes about two-thirds as long and thick as lateral lobes; ventral lobes about two-thirds as long as breadth at base, tips broadly rounded, lobes widely separated at base. Glabrous area of disc extending almost to tips of ventral lobes but not on to dorsal or lateral lobes. Marginal hair fringe absent. Disc with sense and conspicuous dark brown or black patches, as in fig. 86; precise shape of patches variable; patch on each dorsal lobe sometimes more extensive (fig. 87); patch

on each lateral lobe never wider than plate of spiracle. Spiracles slightly oval ; plate brown ; stigmatic scar black peripherally and dark reddish-brown at middle, or entirely black. *Anal field* : marginal band dark brown ; anal papillae reduced to four rounded lobes anterior to anus.





Figs. 86–88.—(86) *Tipula hortulana* Meigen, posterior view of last abdominal segment. (87) *T. hortulana* Meigen, part of spiracular disc to show unusually large patches at bases of dorsal lobes. (88) *T. variipennis* Meigen, ventral lobes of spiracular disc.

Distribution.—Generally distributed. Common.

Comparative notes.—The larva is very similar to that of *T. variipennis* but can be distinguished from it by the characters given in the key.

Habits.—The larvae live in moist rather than wet soil in ditches and woods.

Tipula variipennis Meigen. (Fig. 88).

Last instar larva.—Length, 28 mm. ; breadth, 3 mm. Cuticle unpigmented ; clothed with greyish-brown, moderately dense, very short pubescence that is otherwise as in *T. hortulana*. *Spiracular disc* : as in *T. hortulana* except that pigmentation on each ventral lobe is confined to two dark brown or black spots at base and a large dark brown or black apical patch (fig. 88). *Anal field* : as in *T. hortulana*.

Distribution.—Generally distributed. Common in damp woods.

Comparative notes.—The larva differs from that of the closely related *T. hortulana* only in that the dorsal surface of each ventral lobe is not entirely dark brown, and in that the body pubescence is greyish rather than reddish-brown and is slightly less dense. A third species, *T. pseudovariipennis* Czizek, is closely related to *T. variipennis* and *T. hortulana*, and it seems likely that its larva will be found to be closely similar to those of the two latter species.

Habits.—As for *T. hortulana*.

Tipula unca Wiedemann. (Figs. 89–90).

Last instar larva.—Length, 26 mm.; breadth, 3 mm. Cuticle unpigmented; clothed with pale brown, dense, short pubescence that is slightly longer on dorsal side of last two segments and transversely banded except on pleura; small tufts of long hairs near bases of some of setae. *Spiracular disc* (fig. 89): dorsal and lateral lobes conical with pointed or narrowly rounded tips, lateral lobes about twice as long and thick as dorsal lobes; ventral lobes about half as long as breadth at base, tip of each with a very short latero-ventral projection (fig. 90). Glabrous area of disc extending almost to tips of ventral lobes and on to basal half of each dorsal lobe but not on to lateral lobes; marginal hair fringe present, hairs short. Glabrous area with conspicuous dark brown patches, as in fig. 89. Each dorsal lobe with two short bifid or trifid setae arising just inside hair fringe, one at tip of dark patch, the other on outer margin of patch; patch with a minute unpigmented, probably sensory, plate at middle. Each lateral lobe at base with two short bifid or trifid setae arising just inside hair fringe and immediately above dark patch; patch usually with a narrow lateral extension interrupting hair fringe (fig. 89). Each ventral lobe at tip with three short bifid or trifid setae and a very short unbranched seta arising between hair fringe and dark patch, as in fig. 89. Spiracles slightly oval; plate brown or dark brown, stigmatic scar dark reddish-brown or black. *Anal field*: marginal band dark brown. Four anal papillae anterior to anus (fig. 90); lateral pair pointed, about as long as breadth at base; ventral pair reduced to rounded protuberances.

Distribution.—Generally distributed. Frequent.

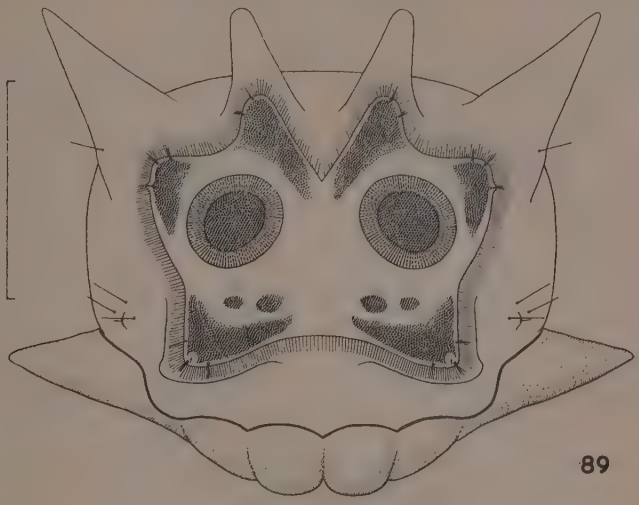
Comparative notes.—The anal field is similar to that of larvae of the *T. oleracea* group, from which *T. unca* is distinguished in the key, but the spiracular disc is quite different and the larva is unlikely to be confused with that of any other species of *Tipula* described here.

Habits.—The larvae live in moist to saturated soil, or under moss-pads in damp places, usually in woods or at the edges of ponds and streams.

Tipula paludosa Meigen. (Figs. 91–93).

Last instar larva.—Length, 45 mm.; breadth, 4 mm. Cuticle unpigmented; clothed with pale greyish-brown, dense, short pubescence that is slightly longer on dorsal side of last two segments; small tufts of longer and usually darker hairs at or near bases of some of the setae. *Spiracular disc* (fig. 91): all lobes tapered, about as long as breadth at base, tips narrowly rounded, and posterior surfaces flattened. Tip of each dorsal and lateral lobe with a small tuft of short hairs. Glabrous area of disc extending to tips of ventral lobes, on to basal half of each lateral lobe, and on to greater part (two-thirds to three-quarters) of each dorsal lobe. Each dorsal lobe with a very short seta at tip of glabrous area just inside hair fringe, and with brown to very pale brown marginal stripes, as in fig. 91; each stripe paler towards tip and with median edge indefinite; outer stripe with a minute circular unpigmented, probably sensory, plate near middle of median edge. Each lateral lobe with four short setae arising just inside hair fringe, two very close together at tip of glabrous area and two widely separated on dorsal margin; dorsal margin unpigmented; ventral margin

with a moderately dark brown stripe that has a darker spot near its tip. Each ventral lobe at base with two dark brown or black spots (sometimes confluent and forming a short transverse stripe) in a pale brown to brown patch that extends broadly to base of inner margin and more narrowly to base of outer margin ; margins otherwise unpigmented ; tip of lobe with an oval or pyriform patch, dark brown at sides and black at middle with a conspicuous unpigmented spot from which arises a long slender seta ; four other setae arise between apical patch and hair fringe, as in fig. 91. Spiracles almost circular ; plate yellowish-brown to brown, stigmatic scar dark brown or black. *Anal field* : marginal band dark brown. Four anal papillae anterior to anus (fig. 92) ; lateral pair conical with



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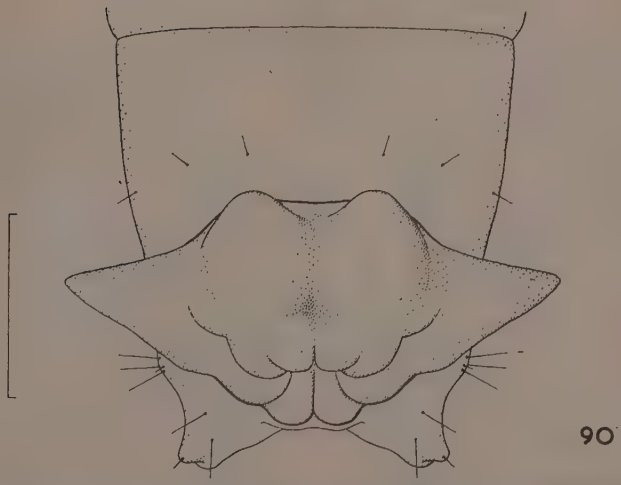

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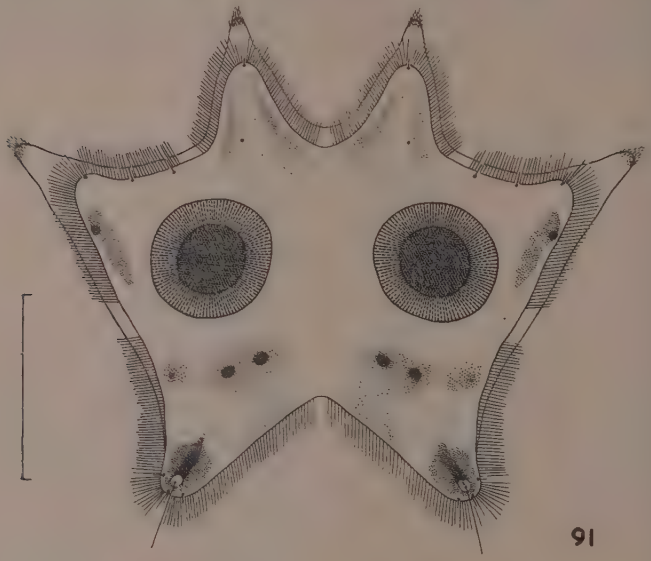
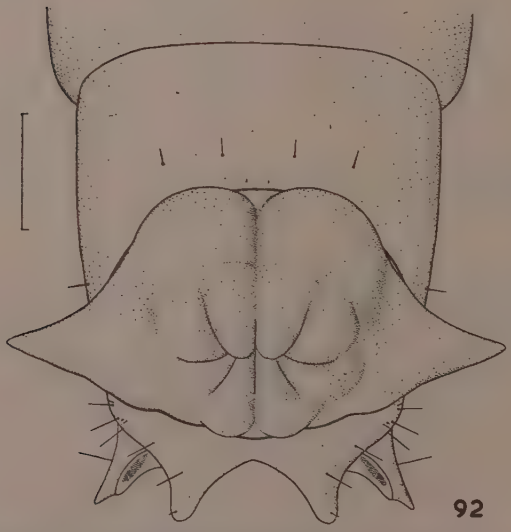
FIGS. 89–90.—*Tipula unca* Wiedemann. (89) Posterior view of last abdominal segment. (90) Ventral view of same.

pointed tips, scarcely longer than breadth at base; ventral pair reduced to rounded protuberances.

Distribution.—Generally distributed. Common.

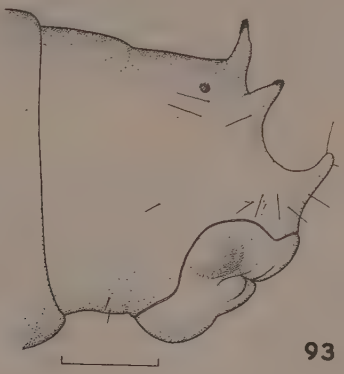
Comparative notes.—The larva of this species cannot be distinguished from those of the other two species of the *T. oleracea* group, namely, *T. oleracea* L.





FIGS. 91–92.—*Tipula paludosa* Meigen. (91) Spiracular disc. (92) Ventral view of last abdominal segment.

and *T. czizeki* De Jong. De Jong (1925) and Sellke (1936) have examined larvae of all three species and have found that the head capsules and mouthparts, the chaetotaxies and the spiracular discs are identical apart from the fact that the head capsule of *T. paludosa* is slightly larger than that of the other two species. The average sizes of the head capsules of the last instar larvae are : *T. paludosa*, length, 3·2 mm., breadth, 2·15 mm.; *T. czizeki* and *T. oleracea*, length, 3·0 mm., breadth, 2·0 mm. Sellke has stated that the body setae of *T. czizeki* larvae are,



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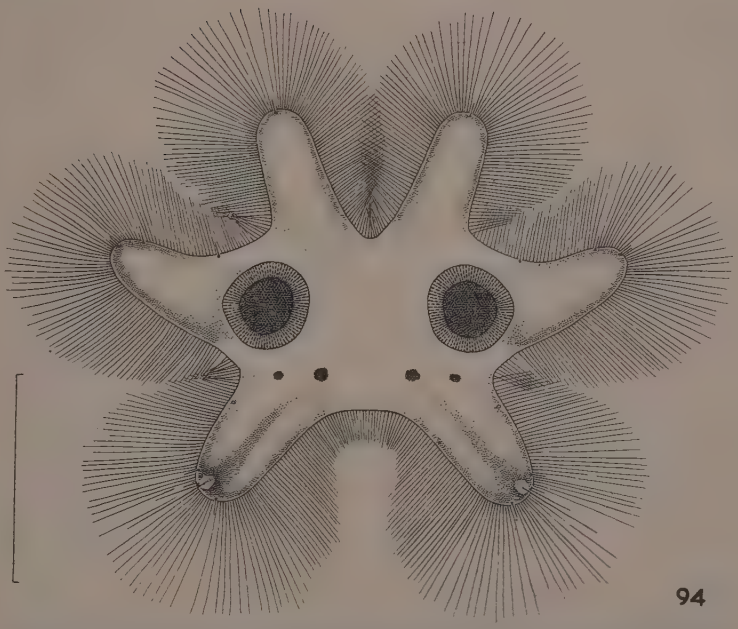

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FIGS. 93–94.—(93) *Tipula paludosa* Meigen, side view of last abdominal segment. (94) *T. cheethami* Edwards, spiracular disc.

in general, stouter than those of *T. paludosa* larvae, but he considered the differences to be insufficient for the separation of the two species. In the present work I have examined larvae of *T. paludosa* and *T. oleracea* and cannot find any constant difference between them.

The first and last instar larvae of *T. paludosa* have been described by Rennie (1917), De Jong (1925) and Sellke (1936); and Oldham (1928) has described the last instar in some detail.

Habits.—The larvae of *T. paludosa*, *T. oleracea* and *T. czizeki* live in very wet to relatively dry soil, usually beneath turf, in woods or in open grassland. *T. paludosa* larvae are well known pests of grain, clover, and many other crops, attacking both roots and shoots. The larvae of the less common *T. oleracea* and *T. czizeki* are also known to cause damage to crops.

Tipula rufina Meigen. (Figs. 98–99).

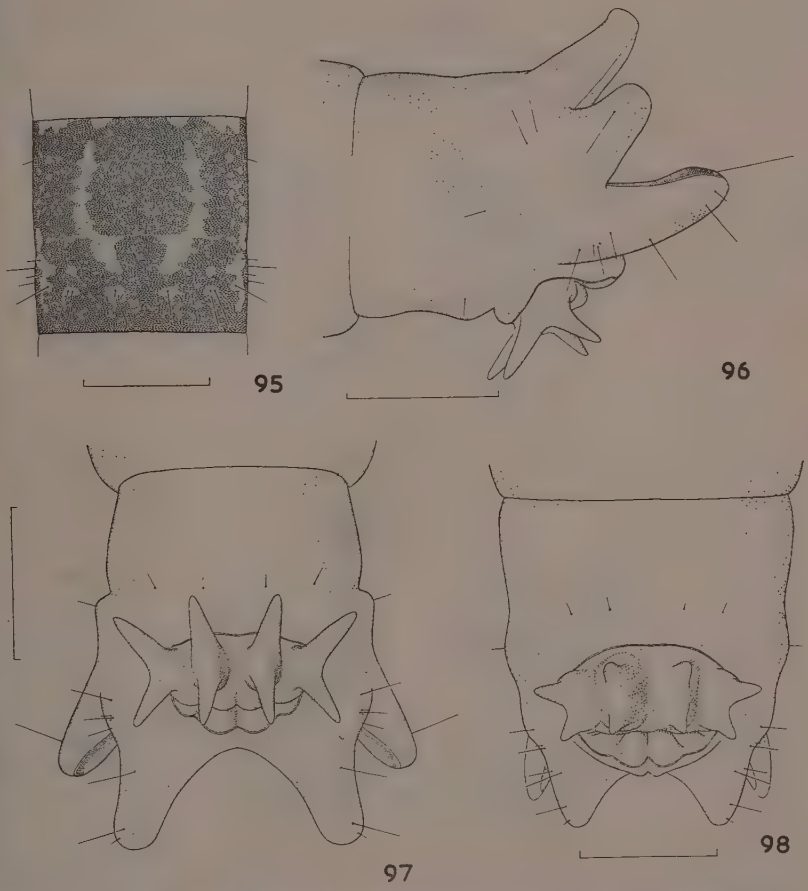
Last instar larva.—Length, 21 mm.; breadth, 2·5 mm. Cuticle unpigmented; clothed with dense, short pubescence; dorsal side moderately dark greyish-brown to brown, with a darker median longitudinal stripe bordered by a pale stripe on each side, stripes indistinct on first segment and absent from last; pleura and ventral side pale greyish-brown. *Spiracular disc* (fig. 99): all lobes moderately short, scarcely longer than breadth at base, and clearly tapered from base to rounded tip; ventral lobes distinctly broader and thicker than either dorsal or lateral lobes and about as long as lateral lobes; dorsal lobes slightly shorter than lateral lobes. Glabrous area of disc extending almost to tips of all lobes; marginal hair fringe present, hairs moderately long. Each dorsal lobe with a very short seta at tip just inside hair fringe; each margin with a narrow moderately pale greyish-brown stripe that is wider at extreme base of lobe; middle of lobe with a narrow pale greyish-brown longitudinal stripe that is often extremely pale or absent. Each lateral lobe with four setae arising just inside hair fringe, two short and very close together at tip and two moderately short and widely separated on dorsal margin; dorsal margin with a narrow to moderately broad, very pale greyish-brown stripe; ventral margin with a distinct, moderately dark brown, wedge-shaped stripe; lobe sometimes with a pale greyish-brown median longitudinal stripe, as in fig. 99. Each ventral lobe pigmented, as in fig. 99; spots at base dark brown or black, sometimes confluent and forming a short transverse stripe; marginal stripes broad and greyish-brown, stripe on outer margin slightly darker than that on inner margin; median longitudinal stripe reddish-brown or dark brown, with paler areas on each side of it distinctly yellowish- or reddish-brown; tip of median stripe with a conspicuous black ring enclosing an unpigmented area from which arises a long slender seta; four other setae at tip just inside hair fringe, as in fig. 99. Spiracles usually slightly oval, greatest diameter 0·29–0·35 mm.; plate pale yellowish-brown, stigmatic scar black. *Anal field*: marginal band pale brown to brown. Eight very short anal papillae arranged in two transverse rows of four anterior to anus (fig. 98); papillae in anterior row slightly longer than those in posterior row but not longer than breadth at base.

Third instar larva.—Length, 10 mm.; breadth, 1·2 mm. Cuticle with pubescence as in last instar but dorsum paler with longitudinal stripes less distinct. *Spiracular disc*: all lobes of same relative size and shape as in last instar, pigmented areas as in last instar except as follows: (1) each dorsal lobe with marginal stripes broader, often confluent at base of lobe, and with median longitudinal stripe always distinct; (2) each lateral lobe with stripe on dorsal margin darker and always moderately broad. Spiracles slightly oval, greatest diameter 0·18–0·21 mm.; plate pale yellow-brown; stigmatic scar usually black peripherally and reddish-brown at middle but sometimes entirely black. *Anal field*: as in last instar.

Distribution.—Generally distributed. Common.

Comparative notes.—The larvae of *T. rufina*, *T. marmorata* Meig. and *T. cheethami* Edw. differ from those of all the other species described here in having eight anal papillae of almost equal length arranged in two transverse rows of four. The only other species described here which have eight anal papillae are *T. maxima* Poda and *T. fulvipennis* Deg., but, in these, four of the papillae are very long and four are very short. The larva of *T. rufina* can be distinguished from those of *T. marmorata* and *T. cheethami* Edw. by the characters given in the key.

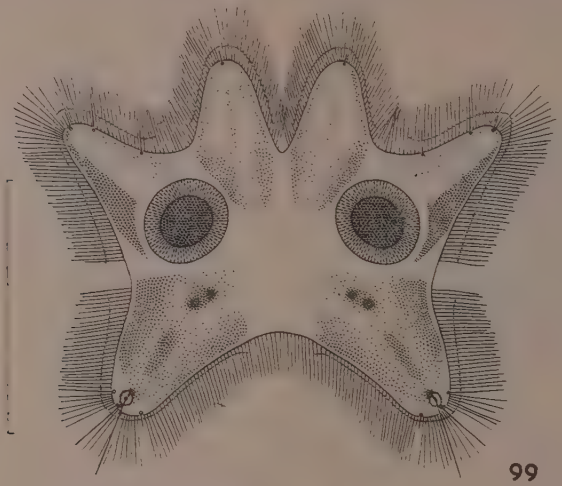
Habits.—The larvae live among mosses in wet or damp places, usually near water and frequently in woods.



FIGS. 95–98.—(95) *Tipula cheethami* Edwards, dorsal view of fifth abdominal segment. (96) Same, side view of last abdominal segment. (97) Same, ventral view of last abdominal segment. (98) *T. rufina* Meigen, ventral view of last abdominal segment.

Tipula marmorata Meigen. (Fig. 100).

Last instar larva.—Length, 20 mm.; breadth, 2·5 mm. Cuticle unpigmented; clothed with pale greyish-brown, dense, very short pubescence that is slightly longer on dorsal side of last segment. Dorsal side not darker than pleura and ventral side, and without longitudinal stripes. *Spiracular disc* (fig. 100): all lobes short, not or scarcely longer than breadth at base, and clearly tapered from base to rounded tip; ventral lobes broader and thicker than either dorsal or lateral lobes and about as long as lateral lobes; dorsal lobes slightly shorter and broader than lateral lobes. Glabrous area of disc extending to tips of ventral lobes and on to greater part of dorsal lobes but restricted to basal halves of lateral lobes; marginal hair fringe present, hairs moderately short. Each dorsal lobe with a very short seta at tip just inside hair fringe, and with a narrow median longitudinal stripe extending



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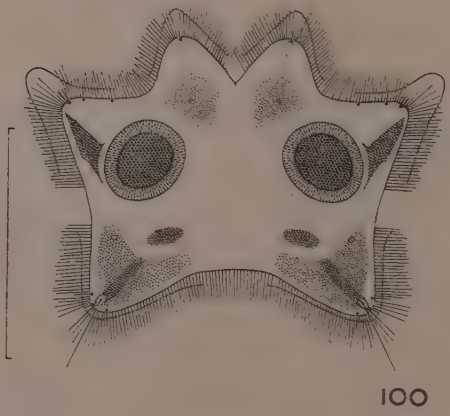

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Figs. 99–100.—(99) Spiracular disc of *Tipula rufina* Meigen.
(100) Same of *T. marmorata* Meigen.

from tip to an irregular triangular or quadrilateral patch at base of lobe ; stripe and patch very pale brown to brown, stripe frequently absent ; patch with a minute circular unpigmented, probably sensory, plate at or near middle. Each lateral lobe with four short setae arising just inside hair fringe, two usually bifid and very close together at tip and two widely separated on dorsal margin ; dorsal margin unpigmented ; ventral margin with a brown or dark brown stripe of somewhat variable shape, but usually as in fig. 100. Each ventral lobe at base with two dark brown or black spots, often confluent and forming a short transverse stripe (fig. 100) ; each margin with a very broad, moderately dark brown stripe that is continuous with a dark brown or black median longitudinal stripe on apical two-thirds to three-quarters of lobe ; apical end of median stripe with an unpigmented spot from which arises a long slender seta ; four other setae at tip of lobe just inside hair fringe, as in fig. 100. Spiracles slightly oval, greatest diameter 0·31–0·40 mm.; plate pale yellow-brown, stigmatic scar usually entirely black but sometimes reddish-brown at middle. *Anal field* : marginal band pale brown or brown. Eight short anal papillae arranged in two transverse rows of four anterior to anus (as in *T. rufina*, fig. 98) ; papillae in anterior row from one to one-and-a-half times as long as breadth at base.

Third instar larva.—Length, 10 mm.; breadth, 1·2 mm. Cuticle with pubescence on dorsum and pleura slightly longer and darker than in last instar. *Spiracular disc* and *anal field* as in last instar ; greatest diameter of spiracule 0·18–0·22 mm.

Distribution.—Generally distributed. Common.

Comparative notes.—The larva is rather similar to that of *T. rufina* but can be distinguished from it by the characters given in the key. There are other differences between the two species : in *T. marmorata* the body pubescence, the hairs of the marginal fringe and the lobes of the spiracular disc are all shorter than in *T. rufina*, but the anal papillae are slightly longer. The plate of the spiracle is narrower in *T. marmorata* than in *T. rufina*.

Habits.—As for *T. rufina*.

Tipula cheethami Edwards. (Figs. 94–97).

Last instar larva.—Length, 20 mm.; breadth, 2 mm. Cuticle unpigmented ; clothed with dense, short, adpressed, silky pubescence ; dorsal side and pleura dark brown with two dorsal and two latero-dorsal pale, interrupted longitudinal stripes and many other small pale spots ; dorsal stripes close together and nearly continuous on first four segments, more widely separated and composed of two curved stripes on each of abdominal segments two to seven (fig. 95) ; latero-dorsal stripes narrow and continuous on second and third segments, but represented behind by a series of small spots on each segment (fig. 95) ; ventral side pale grey-brown. *Spiracular disc* (fig. 94) : all lobes long, about one-and-a-half times as long as breadth at base, scarcely tapered in at least basal halves, tips rounded. Glabrous area of disc extending to tips of all lobes ; marginal hair fringe present, hairs very long—those on at least apical half of each lobe with bases deeply pigmented. Each dorsal lobe with a very short seta at tip just inside hair fringe ; and with narrow brown marginal stripes continuous at tip, stripes paler near base of lobe and with inner edge indefinite ; lobe very pale brown between stripes except at tip and here unpigmented. Each lateral lobe with four very short setae arising just inside hair fringe, two very close together at tip and two widely separated on dorsal margin ; tip and each margin with a narrow brown stripe, dorsal marginal stripe pale brown near base, ventral marginal stripe broader near base and continuous with a pale brown stripe around outer edge of spiracle ; lobe otherwise very pale brown. Each ventral lobe with two dark brown or black spots at base, and with a brown tapered median longitudinal stripe extending from tip of lobe almost to inner basal spot ; each margin with a narrow dark brown stripe, paler near base and with inner edge indefinite ; tip dark brown or black with an unpigmented spot from which arises a long slender seta,

and with four other setae that arise just inside hair fringe, as in fig. 94. Spiracles usually somewhat angular in outline; plate pale brown or brown, stigmatic scar dark brown or black. *Anal field*: marginal band brown. Eight short and slender anal papillae in two transverse rows of four anterior to anus (figs. 96 and 97); papillae in anterior row more than twice as long as breadth at base, those in posterior row about one-and-a half times as long as breadth at base.

Distribution.—SCOTLAND southwards to SOMERSET (Failand, near Bristol). Frequent in damp mossy places, principally in mountainous areas.

Comparative notes.—The larva of this species resembles those of *T. rufina* and *T. marmorata* but can be distinguished from them by the characters given in the key. The lobes of the spiracular disc and the hairs of the marginal fringe are distinctly longer than those of the two latter species, and both the pleura and the dorsum are dark brown, whereas in *T. rufina* only the dorsum is darkened and in *T. marmorata* the larva is entirely pale greyish-brown.

Habits.—The larvae live among mosses and liverworts that grow at the edges of streams and on exposed stones and logs in the streams themselves.

Tipula solstitialis Westhoff. (Figs. 101–102, 104).

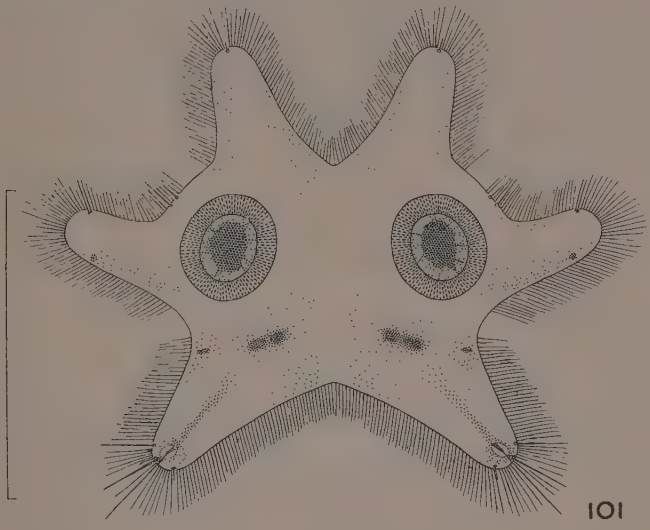
Last instar larva.—Length, 27 mm.; breadth, 2·5 mm. Cuticle unpigmented; clothed with dense and largely very short pubescence, with small tufts of longer hairs at or near bases of some setae and large patches of such hairs on dorsal side of last one or two segments. Dorsal side greyish-brown, with a slightly darker median longitudinal stripe bordered on each side by a pale interrupted stripe, and with many small pale patches at bases of setae and elsewhere (fig. 102); ventral side and usually pleura pale greyish-brown. *Spiracular disc* (fig. 101): all lobes tapered, slightly longer than breadth at base, with posterior surfaces flattened. Glabrous area of disc extending to tips of ventral lobes and almost to tips of dorsal and lateral lobes; marginal hair fringe present, hairs moderately long. Each dorsal lobe with a short seta at tip just inside hair fringe, and with pale to very pale greyish-brown marginal stripes, as in fig. 101. Each lateral lobe with four setae arising just inside hair fringe, two moderately long and very close together at tip, and two moderately close together at extreme base of dorsal margin; ventral margin with a moderately broad pale or very pale brown stripe that has a dark spot near its tip; dorsal margin with a narrower and usually paler stripe that is often incomplete near tip. Each ventral lobe at base extremely pale greyish-brown, with two small brown to black spots that are sometimes confluent and form a short transverse stripe; each margin with a narrow and usually very pale greyish-brown stripe that is frequently incomplete near tip of lobe, base of outer margin with a small dark spot; a narrow median longitudinal stripe extends from tip of lobe almost to basal spots, stripe reddish-brown or dark brown at tip, paler and yellowish-brown near base; tip of lobe slightly darkened around an unpigmented spot from which arises a long slender seta, and with four other setae arising just inside hair fringe, as in fig. 101. Spiracles slightly oval; plate pale yellow-brown, stigmatic scar either entirely black or with periphery pale, as in fig. 101. *Anal field*: marginal band dark brown. Four very long and slender anal papillae anterior to anus (fig. 104); lateral pair about five times as long as breadth at base, ventral pair slightly shorter.

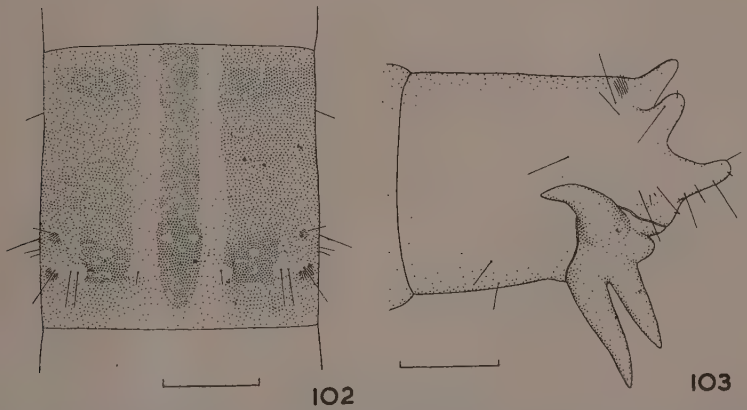
Distribution.—Generally distributed. Uncommon.

Comparative notes.—The larva can be easily distinguished from that of *T. lateralis* Meig. because it has only four anal papillae, whereas the latter has six. Apart from this and excepting other possible differences in the head

capsules, which have not been examined, the larva is entirely similar to that of *T. lateralis*.

Habits.—The larvae live in leaf mould or in moderately wet to saturated soil in marshy fields or at the edges of ponds and streams.





FIGS. 101–103.—(101) *Tipula solstitialis* Westhoff, spiracular disc. (102) Same, dorsal view of fifth abdominal segment. (103) *T. lateralis* Meigen, side view of last abdominal segment.

Tipula lateralis Meigen. (Figs. 103, 105).

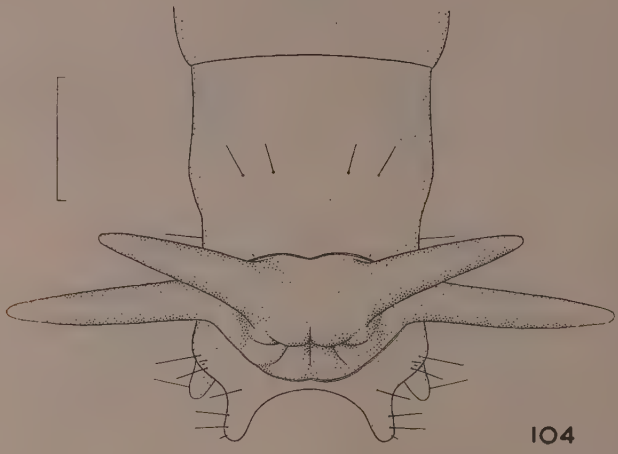
Last instar larva.—Length, 28 mm.; breadth, 3 mm. Cuticle with pubescence as in *T. solstitialis*. *Spiracular disc* : entirely similar to that of *T. solstitialis*. *Anal field* : marginal band dark brown. Six long and slender anal papillae anterior to anus (figs. 103 and 105) ;

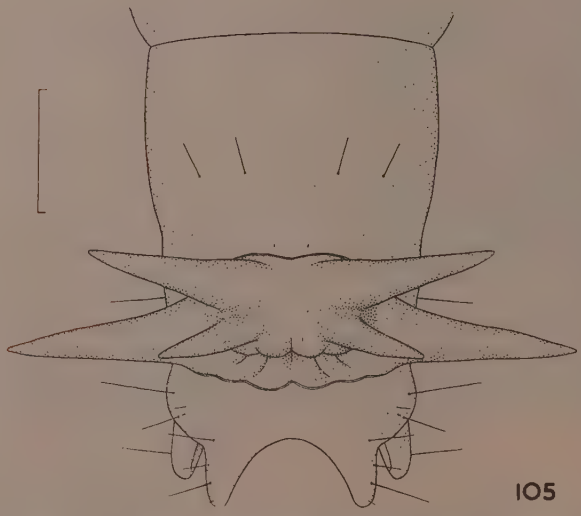
lateral pair and anterior ventral pair three to four times as long as breadth at base, posterior ventral pair narrower and about half as long as lateral pair.

Earlier stages.—According to White (1951), the second and third instar larvae are identical to the last instar, apart from size.

Distribution.—Generally distributed. Common.

Comparative notes.—The colour of the dorsal side of at least the last instar larva varies considerably, as noted by Levy (1919), from pale greyish-brown to moderately dark brown, but the longitudinal stripes are always distinct. The





Figs. 104–105.—(104) Ventral view of last abdominal segment of *Tipula solstitialis* Westhoff. (105) Same of *T. lateralis* Meigen.

stripes and patches on the lobes of the spiracular disc also vary in colour and the marginal stripes on the dorsal and ventral lobes, together with the dorsal marginal stripe on each lateral lobe, are often extremely pale and difficult to see. The median longitudinal stripe and the two basal spots on each ventral lobe are, however, always distinct.

Oldham (1928) has described the last instar, including the head capsule and mouthparts, in some detail, and White (1951) has given an account of the life-history.

Habits.—The larvae live in moderately wet to saturated soil and leaf mould in marshy fields or at the edges of ponds and streams. Although the larvae are normally not carnivorous, I have found a single specimen which was eating a small Chironomid larva whole.

Tipula pruinosa Wiedemann. (Figs. 106–110).

Last instar larva.—Length, 22 mm.; breadth, 2·5 mm. Cuticle unpigmented; clothed with dense and largely very short pubescence; dorsal and ventral sides of abdominal segments two to seven with numerous tufts of longer hairs arranged in several transverse bands in each segment (figs. 107 and 108); dorsal side of last segment largely clothed with moderately long hairs, and with two pairs of small rounded protuberances that are densely covered with very long hairs, first pair latero-dorsal at middle of segment (fig. 110), second pair dorsal immediately anterior to spiracular disc (figs. 106 and 109). Dorsal side pale brown with three moderately dark brown or greyish-brown interrupted longitudinal stripes, median stripe narrower than lateral stripes; ventral side pale brown; pleura very pale brown. *Spiracular disc* (fig. 106): all lobes small, about as long as breadth at base, tips rounded; each lateral lobe with an apical tuft of long hairs (figs. 106 and 110). Glabrous area of disc extending to tips of dorsal and ventral lobes and on to basal two-thirds of lateral lobes; marginal hair fringe present, hairs moderately long. Each dorsal lobe with a very short seta at tip just inside hair fringe, and with pale brown marginal stripes. Each lateral lobe with four short setae on dorsal margin just inside hair fringe, two very close together near tip and two moderately close together at extreme base; each margin with a pale brown stripe, ventral stripe slightly darker than dorsal stripe and with a blackish spot near tip. Each ventral lobe at base with a short dark brown transverse stripe; each margin with a brown stripe, outer stripe slightly darker than inner; tip with a dark brown to black patch and with a conspicuous unpigmented spot from which arises a long slender seta; four other setae arise at tip just inside hair fringe, as in fig. 106. Spiracles slightly oval; plate brown, stigmatic scar black. *Anal field*: marginal band brown. Six anal papillae anterior to anus (figs. 106 and 110); lateral pair three to four times as long as breadth at base, antero-ventral pair about twice as long as breadth at base, postero-ventral pair scarcely longer than breadth at base.

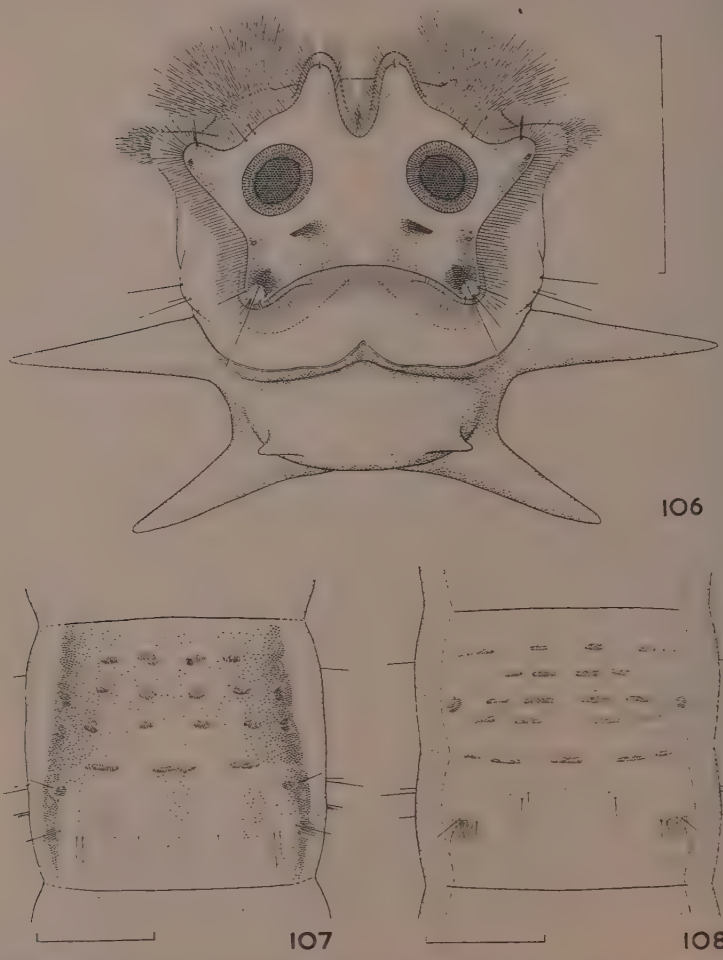
Distribution.—Generally distributed. Frequent.

Comparative notes.—The numerous hair tufts on the body and the more conspicuous tufts on the dorsal side of the last segment are not present in any of the other species described here. The larvae of *T. lateralis* and *T. solstitialis* resemble that of *T. pruinosa* in that they have dark longitudinal stripes on the dorsum and at least four long and slender anal papillae, but they lack the hair tufts described above and the lobes of their spiracular discs are distinctly longer than those of *T. pruinosa*. It may be noted here that the larva described by Beling (1886) as *T. pruinosa* Wied. is certainly not this species.

Habits.—The larvae live in wet soil in marshy places.

Tipula flavolineata Meigen. (Figs. 28–31, 65).

Last instar larva.—Length, 30 mm.; breadth, 4 mm. Cuticle unpigmented; thoracic segments clothed with very short, adpressed, pale yellow-brown pubescence; abdominal segments glabrous. *Spiracular disc* (fig. 65): all lobes very short; dorsal and lateral lobes conical and pointed, from one-half to three-quarters as long as breadth at base; ventral lobes broadly rounded, scarcely half as long as breadth at base. Marginal hair fringe absent. Each dorsal lobe with a very short usually bifid seta near base, and with a small pale brown patch just below seta (patch sometimes absent). Each lateral lobe with a short pale brown or brown stripe across base, and with four very short bifid or trifid setae, two very close

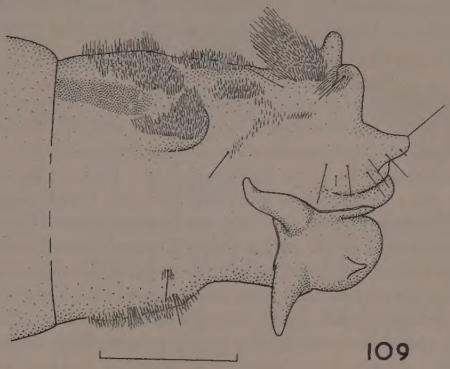


Figs. 106–108.—*Tipula pruinosa* Wiedemann. (106) Posterior view of last abdominal segment. (107) Dorsal view of fifth abdominal segment. (108) Ventral view of fifth abdominal segment.

together near dorso-lateral corner of stripe and two close together at extreme base of dorsal margin of lobe ; middle of outer (i.e. ventral) side of lobe with a long stout seta. Each ventral lobe at tip with a moderately small, brown, angular or V-shaped stripe and with seven setae, one long and rather stout and six very short, as in fig. 65. Spiracles oval ; plate pale brown, stigmatic scar either entirely dark brown or with pale brown periphery. *Anal field* : marginal band pale brown. Anal papillae reduced to four rounded lobes, two on each side of anus.

Distribution.—Generally distributed. Frequent in woods.

Comparative notes.—The larva is similar to that of *Tanyptera atrata* L. but the dorsal and lateral lobes of the spiracular disc are pointed, not rounded as in *T. atrata*. The two species also differ in the position and number of the setae



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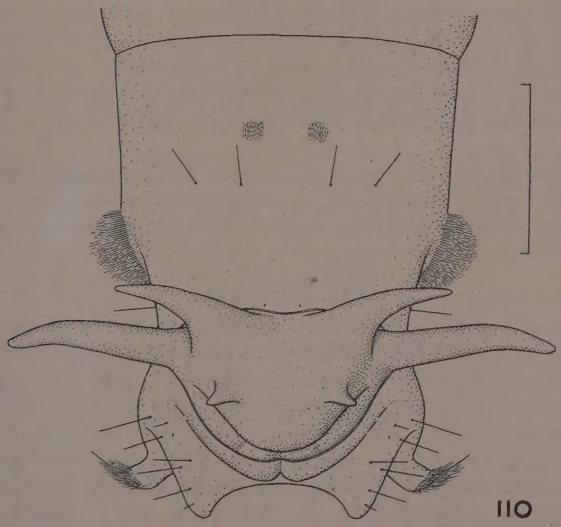

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FIGS. 109–110.—*Tipula pruinosa* Wiedemann. (109) Side view of last abdominal segment, (110) Ventral view of same.

on the lateral and ventral lobes of the disc, as described in the key. It should be noted that Hennig's (1950) fig. 214 shows the spiracular disc of *Tipula flavolineata*, not that of *Tanyptera atrata* as he states.

The head capsule and mouthparts of the larva of *T. flavolineata* have been described in some detail by Wardle and Taylor (1926).

Habits.—The larvae live in decaying, although often fairly hard, wood.

Tipula subnodicornis Zetterstedt.

The larva of this species apparently differs from those of all the other Palaearctic species that are known as larvae in that the spiracular disc is surrounded by eight rather than six lobes. The fourth pair of lobes is situated between the usual lateral and ventral lobes and may be called the latero-ventral lobes. I have not seen the larva of this species and the description which follows is based entirely on that of Beling (1886).

Mature larva.—Length, 17 mm.; breadth, 2·5 mm. Yellowish-grey, ventral side paler than dorsal side, which has three dark longitudinal stripes. Dorsal side of each segment with a transverse row of four to six small tooth-like processes ; each process short and broad with a heavily sclerotised backwardly directed tip, lateral processes larger than median ones. *Spiracular disc* : dorsal lobes short and rounded, occasionally fused together ; each with two short dark brown marginal stripes. Lateral lobes short and broad with truncate tips ; each with a brown patch at tip. Each latero-ventral lobe long and narrow with blackened heavily sclerotised tip and with two short brownish marginal stripes at base. Ventral lobes widely separated, each short and rounded with a blackish comma-shaped patch at base and a dark brown patch at tip. Spiracles circular. *Anal field* : four long and pointed anal papillae in a transverse row, lateral papillae longer than ventral papillae.

Distribution.—Generally distributed. Common near bogs.

Comparative notes.—Apart from the presence of eight rather than six lobes around the spiracular disc, the larva differs from those of all the other species described here in having tooth-like processes on the body. According to Beling (1873, 1878 and 1886) similar processes are present on the larvae of *T. pabulina* Meig., *T. truncorum* Meig. and *T. winnertzii* Egg. The first two of these species are British.

Habits.—Beling found larvae in soil in a wet field. Audcent (1932) describes the adults as being plentiful only on bogs where cotton-grass (*Eriophorum vaginatum* L.) grows, so that the larvae may feed largely on this particular plant.

VII. Parasites.

The larvae of several species of Tachinidae are parasitic in larvae of Tipulinae. According to Audcent (1942), *Trichoparia seria* Meig. has been bred from *Dictenidia bimaculata* L., *Ctenophora pectinicornis* L. and *Tanyptera atrata* L.; *Bucentes geniculata* Deg. has been bred from *Tipula maxima* Poda, *T. oleracea* L. and *T. paludosa* Meig.; and *Bucentes cristata* Fab. has been bred from *T. maxima*. In the course of the present work *Trichoparia seria* has been bred from *Tipula lunata* L. and *T. hortulana* Meig., and *Bucentes geniculata* has been bred from *Tipula fulvipennis* Deg., *T. vittata* Meig. and *T. lateralis* Meig.

Gregarine Sporozoa have been found, usually in large numbers, in the mid- and hind-gut of some individuals of *Tipula paludosa*, *T. maxima* and *T. fulvi-*

pennis. They occur between the epithelium and the peritrophic membrane. Nematodes occasionally occur in the gut of these three species and are found with the food inside the peritrophic membrane.

VIII. Summary.

The last instar larvae of thirty-six British species of Tipulinae are described and illustrated, and a key to these species is provided. A general account of larval characters that are of taxonomic importance is given.

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